Protocol API

CANopen Slave

V3.6.x.x

Hilscher Gesellschaft für Systemautomation mbH

www.hilscher.com

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1 Introduction

1.1 Abstract

This manual describes the application interface of the CANopen Slave stack, with the aim to support and lead you during the integration process of the given stack into your own application.

Base of the development of the stack itself is the Hilscher's Task Layer Reference Programming Model. It is a description of how to program a Task in general, which is defined as a combination of appropriate functions belonging to the same type of protocol layer. It furthermore defines of how different Tasks have to communicate with each other in order to exchange their layer information in between. The reference model is commonly used by all programmers at Hilscher and shall be used by you as well when writing your Application Task on top of the stack.

1.2 List of Revisions

Rev	Date	Name	Revisions
1	2012-03-09	RG/ES	Firmware/stack version V3.1.2.x Reference to netX Dual-Port Memory Interface Manual Revision 12. Reference to Object Dictionary V3.2.8.0 First final version
2	2012-07-04	RG/ES	Firmware/stack version V3.2.x.x Added description of packet `RCX_SET_FW_PARAMETER_REQ/CNF` – Set the Value of the Firmware Parameter
3	2013-04-11	RG/ES	Firmware/stack version V3.4.3.x Reference to Object Dictionary V3.3.1.x Reference to CAN_DL V2.0.22.0 Added description of packet `RCX_GET_FW_PARAMETER_REQ/CNF` – Get the Value of the Firmware Parameter Added description of packet `CANOPEN_SLAVE_SEND_EMCY_IND/RES` – Emergency Message Indication Adapted description of packet `CANOPEN_SLAVE_SET_EVENTS_INDICATED_REQ/CNF` – Set Events Indicated Request to new Send EMCY Event Adapted *Table 51: Packets of CANopen Slave Protocol Stack V3 and Restrictions of Usage for* new Send EMCY Event
4	2013-05-22	RG/ES	Firmware/stack version V3.5.1.x Reference to Object Dictionary V3.3.1.x Reference to CAN_DL V2.0.23.0 netX52 now supported
5	2013-10-29	RG/ES	Firmware/stack version V3.6.2.x Reference to Object Dictionary V3.3.2.x Reference to CAN_DL V2.0.27.0 Technical data updated (number of consumers for netX51/52) Small corrections

Table 1: List of Revisions

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1.3 System Requirements

The software package has the following system requirements to its environment:

- netX-Chip as CPU hardware platform
- Operating system for task scheduling required

1.4 Intended Audience

This manual is suitable for software developers with the following background:

- Knowledge of the programming language C
- Knowledge of the use of the real-time operating system rcX
- Knowledge of the Hilscher Task Layer Reference Model
- Knowledge of the CiA Work Draft 301 specification

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1.5 Specifications

The data below applies to CANopen Slave firmware and stack version 3.6.x. The firmware/stack has been designed in order to meet the CiA Work Draft 301 V4.02 specification (see reference [2]).

1.5.1 Technical Data

Technical Data

Features	Parameter
Maximum number of input data	Depends on the used mode and settings. See below.
Maximum number of output data	Depends on the used mode and settings. See below.
Maximum number of receive PDOs	Depends on the used mode and settings. See below.
Maximum number of transmit PDOs	Depends on the used mode and settings. See below.
Exchange of process data	via PDO transfer (synchronized, remotely requested, event driven (change of date)), requested by application (via packet))
Acyclic communication	SDO Up- and Download (Server only), Emergency message (producer), Timestamp (producer/consumer)
Functions	Node guarding / life guarding, heartbeat 1 producer max. 64 consumer (netX 50/51/100/500) max. 32 consumer (netX 52) max. 4 consumer (netX 10) PDO Mapping NMT Slave SYNC protocol (consumer) Error behavior in state operational: change to state pre-operational no state change change to state stopped
Baud rates	10 kBit/s to 1 MBit/s Automatic detection
Data transport layer	CAN Frames can be accessed by programming the CAN DL layer, see reference [5]
CAN Frame type	11 Bit 11/29 Bit layer 2 transparent

Table 2: Technical Data - Protocol Stack

Firmware/stack available for netX

netX	Available
netX 10	yes
netX 50	yes
netX 51	yes (since stack V3.3.1)
netX 52	yes (since stack V3.5.1)
netX 100, netX 500	yes

Table 3: Technical Data – Available for netX

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PCI - DMA

Features	Parameter
DMA Support for PCI targets	yes

Table 4: Technical Data – PCI-DMA

Slot Number

Features	Devices
Slot number supported for	CIFX 50-CO, CIFX 50E-CO, CIFX 70E-CO

Table 5: Technical Data – Slot Number

Configuration

For configuration of standard mode with default settings:

- by SYCON.net configuration software (Download or exported configuration file named config.nxd),
- by netX Configuration tool.

For configuration of standard mode with default settings and configured settings and extended mode:

- by packet to transfer configuration parameters.

Diagnostic

Firmware supports common and extended diagnostic in the dual-port-memory for loadable firmware

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1.5.1.1 Technical Data (Standard Mode)

In standard mode, the following values and limitations apply:

Technical Data for default Settings

Features	Parameter
Default number of input data	512 bytes (netX 50/100/500) 64 bytes (netX 10)
Default number of output data	512 bytes (netX 50/100/500) 64 bytes (netX 10)
Default number of receive PDOs	64 (netX 50/100/500) 8 (netX 10)
Default number of transmit PDOs	64 (netX 50/100/500) 8 (netX 10)

Table 6: Technical Data - Protocol Stack (Standard Mode – Default Settings)

Note: The EDS files for Hilscher standard products contain the functionality that matches the default settings. SYCON.net and the netX Configuration tool only configure the default settings.

Technical Data for configured Settings

Features	Parameter
Maximum number of input data	1020 bytes
Maximum number of output data	1020 bytes
Number of receive PDOs	0 … 255 (netX 50/100/500) for mapping objects 2200 … 2203 0 … 8 (netX 10) for mapping objects 2200 … 2203
Number of transmit PDOs	0 … 255 (netX 50/100/500) for mapping objects 2000 … 2003 0 … 8 (netX 10) for mapping objects 2000 … 2003

Table 7: Technical Data - Protocol Stack (Standard Mode – Configured Settings)

Note 1: Using other settings than the default settings requires a suitable EDS file.

Note 2: The actual maximum number of IO Data and PDOs depends on the **available amount of memory**.

Note 3: SYCON.net and netX configuration tool do not support the configuration of the extended mode.

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1.5.1.2 Technical Data (Extended Mode)

In extended mode, the stack offers extended functionality. To use these functions requires an application program that configures and supports these functions, e.g. to create an own object dictionary.

In extended mode, more input and output data can be used and transmit and receive PDOs can be used.

Note: The actual maximum number of IO Data and PDOs depends on the **available amount of memory**.

To use the extended mode requires creating a suitable EDS file. The knowledge of the EDS specification is required.

Features	Parameter
Maximum number of input data	2048 bytes
Maximum number of output data	2048 bytes
Maximum number of receive PDOs	256
Maximum number of transmit PDOs	256

Table 8: Technical Data - Protocol Stack (Extended Mode)

Other settings than default must be set via “Set Configuration Packet” and object dictionary configuration.

Concerning the extended mode, also see section *Standard Mode vs. Extended Mode* on page 68.

Note: SYCON.net and netX configuration tool do not support the configuration of the extended mode.

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1.6 Terms, Abbreviations and Definitions

Term	Description
AP	Application on top of the Stack
Boot up	Initial sequence of node during start-up
CAN	Controller Area Network
CAN-DL	CAN Data Link Layer
CiA	CAN in Automation (CAN User Organization located in Erlangen, Germany)
COB-ID	Communication Object Identifier
DPM	Dual Port Memory
EMCY	Emergency
Guarding	Supervision of node
NMT	Network Management
OD	Object Dictionary
ODV3	Object Dictionary Version 3
PDO	Process Data Object (process data channel)
PDO-Mapping	Configurable process data per PDO
RTR	Remote transmission request
RxPDO	Receive PDO
SDO	Service Data Object (representing an acyclic data channel)
SYNC	Synchronization cycle of the CANopen slave
TxPDO	Transmit PDO

Table 9: Terms, Abbreviations and Definitions

All variables, parameters and data used in this manual have basically the LSB/MSB (“Intel”) data representation. This corresponds to the convention of the Microsoft C Compiler.

1.7 References to Documents

This document refers to the following documents:

[1] EN 50325/4 Specification

[2] CAN in Automation e.V., Nuremberg: CANopen Application Layer and Communication Profile, CiA Public Specification 301, Version 4.2.0, 2011

[3] Hilscher Gesellschaft für Systemautomation mbH: Dual-Port Memory Interface Manual, netX based products. Revision 12, English, 2008-2012

[4] Hilscher Gesellschaft für Systemautomation mbH: Object Dictionary Version 3 Manual, 2008-2013

[5] Hilscher Gesellschaft für Systemautomation mbH: CAN Data Link Packet Interface Protocol API Manual 1.0, 2010-2013

Table 10: References

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2 Fundamentals

2.1 General Access Mechanisms on netX Systems

This chapter explains the possible ways to access a Protocol Stack running on a netX system :

1. By accessing the Dual Port Memory Interface directly or via a driver.
2. By accessing the Dual Port Memory Interface via a shared memory.
3. By interfacing with the Stack Task of the Protocol Stack.

The picture below visualizes these three ways:

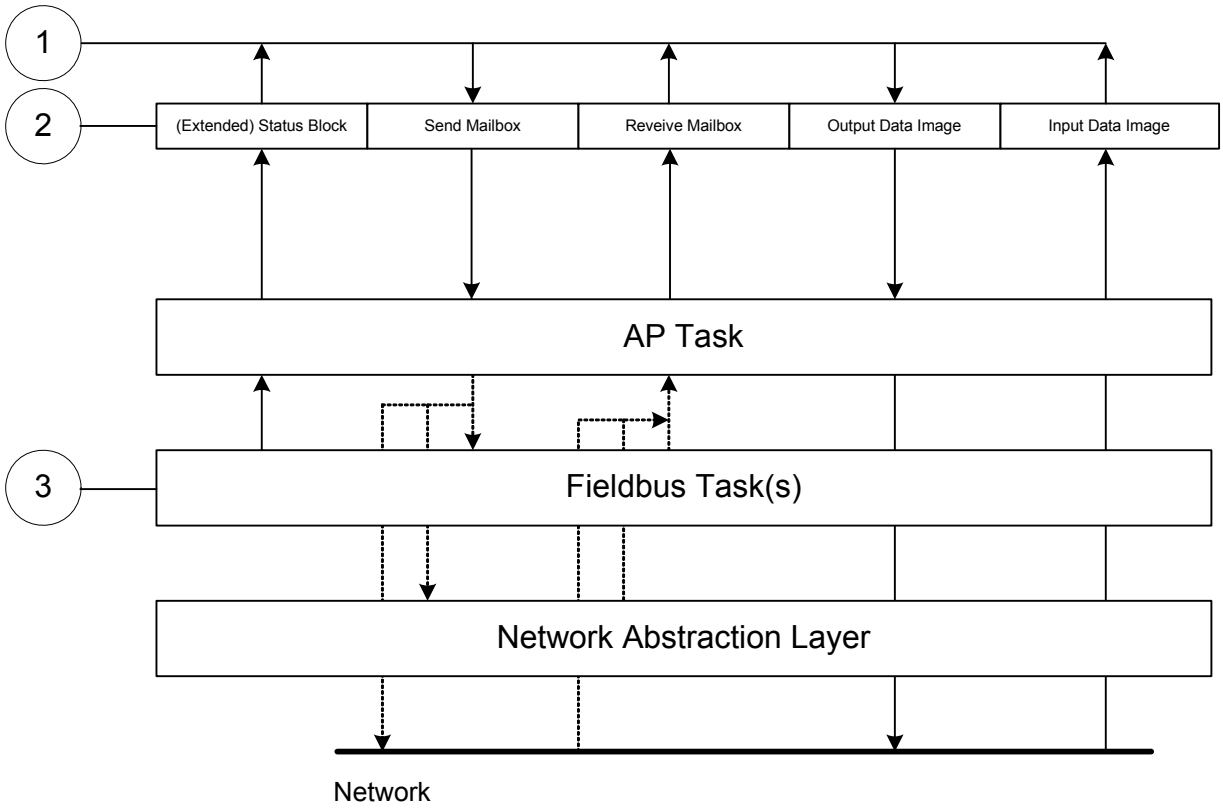

Figure 1: The 3 different Ways to access a Protocol Stack running on a netX System

This chapter explains how to program the stack (alternative 3) correctly while the next chapter describes accessing the protocol stack via the dual-port memory interface according to alternative 1 (and 2, if the user application is executed on the netX chip in the context of the rcX operating system and uses the virtual DPM). Finally, chapter 5 titled "*The Application Interface*" describes the entire interface to the protocol stack in detail.

Depending on you choose the stack-oriented approach or the Dual Port Memory-based approach, you will need either the information given in this chapter or those of the next chapter to be able to work with the set of functions described in chapter 5. All of those functions use the four parameters `ulDest, ulSrc, ulDestId and ulSrcId`. This chapter and the next one inform about how to work with these important parameters.

2.2 Accessing the Protocol Stack by Programming the AP Task's Queue

In general, programming the AP task or the stack has to be performed according to the rules explained in the Hilscher Task Layer Reference Manual. There you can also find more information about the variables discussed in the following.

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2.2.1 Getting the Receiver Task Handle of the Process Queue

To get the handle of the process queue of the CANopen Slave-Task the Macro `TLR_QUE_IDENTIFY()` needs to be used. It is described in detail within section 10.1.9.3 of the Hilscher Task Layer Reference Model Manual. This macro delivers a pointer to the handle of the intended queue to be accessed (which is returned within the third parameter, `phQue`), if you provide it with the name of the queue (and an instance of your own task). The correct ASCII-queue name for accessing the CANopen Slave-Task which you have to use as current value for the first parameter (`pszIdn`) is

ASCII queue name	Description
"QUE_CANOPENSLV"	Name of the CANopen slave-Task process queue
"QUE_COS_ODV3"	Name of the CANopen slave- Task ODV3 process queue
"QUE_CANOPENAPS"	Name of the APS-Task process queue
"CAN_DL_QUE"	Name of CAN-DL-Task process queue

Table 11: ASCII Queue Name

The returned handle has to be used as value `ulDest` in all initiator packets the AP-Task intends to send to the CANopen slave. This handle is the same handle that has to be used in conjunction with the macros like `TLR_QUE_SENDPACKET_FIFO/LIFO()` for sending a packet to the respective task.

2.2.2 Meaning of Source- and Destination-related Parameters

The meaning of the source- and destination-related parameters is explained in the following table:

Variable	Meaning
ulDest	Application mailbox used for confirmation
ulSrc	Queue handle returned by `TLR_QUE_IDENTIFY()` as described above.
ulSrcId	Used for addressing at a lower level

Table 12: Meaning of Source- and Destination-related Parameters

For more information about programming the AP task's stack queue, please refer to the Hilscher Task Layer Reference Model Manual. Especially the following sections might be of interest in this context:

1. Section 7 "Queue-Packets"
2. Section 10.1.9 "Queuing Mechanism"

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2.3 Accessing the Protocol Stack via the Dual Port Memory Interface

This chapter defines the application interface of the CANopen Slave stack V3.

2.3.1 Communication via Mailboxes

The mailbox of each communication channel has two areas that are used for non-cyclic message transfer to and from the netX.

- **Send Mailbox**
  Packet transfer from host system to firmware
- **Receive Mailbox**
  Packet transfer from firmware to host system

For more details about acyclic data transfer via mailboxes see section 3.2. The concept of using messages called packets in this context, is described in detail in section 3.2.1 “General Structure of Messages or Packets for Non-Cyclic Data Exchange” while the possible codes that may appear are listed in section 3.2.2. “Status & Error Codes”.

However, this section concentrates on correct addressing the mailboxes.

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2.3.2 Using Source and Destination Variables correctly

2.3.2.1 How to use ulDest for Addressing rcX and the netX Protocol Stack by the System and Channel Mailbox

The preferred way to address the netX operating system rcX is through the system mailbox; the preferred way to address a protocol stack is through its channel mailbox. All mailboxes, however, have a mechanism to route packets to a communication channel or the system channel, respectively. Therefore, the destination identifier *ulDest* in a packet header has to be filled in according to the targeted receiver. See the following example.

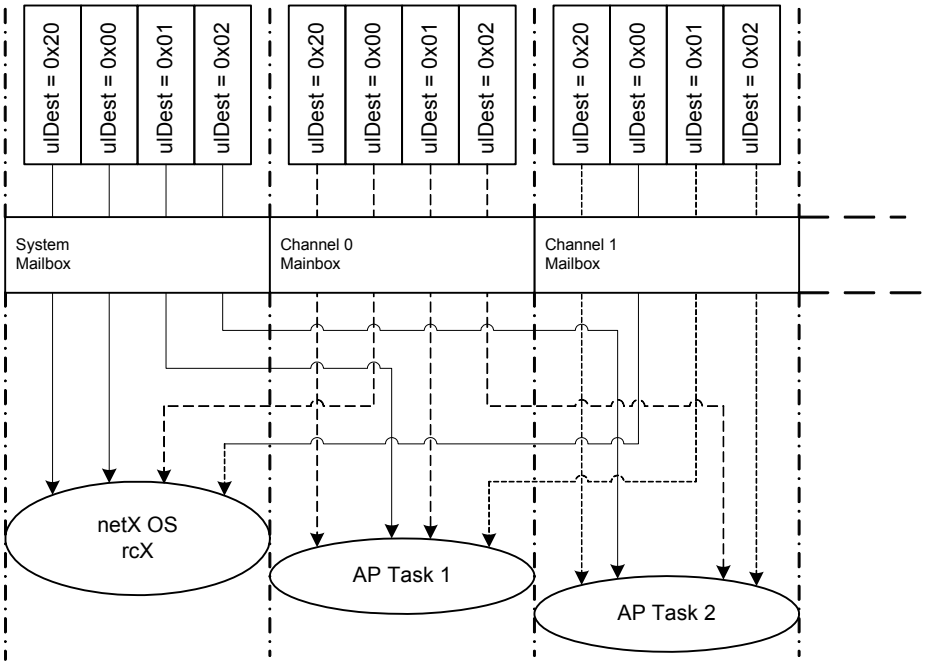

Figure 2: Use of `ulDest` *in Channel and System Mailbox*

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For use in the destination queue handle, the tasks have been assigned to hexadecimal numerical values as described in the following table:

ulDest	Description
0x00000000	Packet is passed to the netX operating system rcX
0x00000001	Packet is passed to communication channel 0
0x00000002	Packet is passed to communication channel 1
0x00000003	Packet is passed to communication channel 2
0x00000004	Packet is passed to communication channel 3
0x00000020	Packet is passed to communication channel of the mailbox
else	Reserved, do not use

Table 13: Destination Queue Handle

The picture and the table above both show the use of the destination identifier *ulDest*.

A remark on the special channel identifier 0x00000020 (= *Channel Token*). The Channel Token is valid for any mailbox. That way the application uses the same identifier for all packets without actually knowing which mailbox or communication channel is applied. The packet stays 'local'. The system mailbox is a little bit different, because it is used to communicate to the netX operating system rcX. The rcX has its own range of valid commands codes and differs from a communication channel.

Unless there is a reply packet, the netX operating system returns it to the same mailbox the request packet went through. Consequently, the host application has to return its reply packet to the mailbox the request was received from.

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2.3.2.2 How to use `ulSrc` and `ulSrcId`

Generally, a netX protocol stack can be addressed through its communication channel mailbox. The example below shows how a host application addresses a protocol stack running in the context of a netX chip. The application is identified by a number (#444 in this example). The application consists of three processes identified by the numbers #11, #22 and #33. These processes communicate through the channel mailbox with the AP task of the protocol stack. Have a look at the following image:

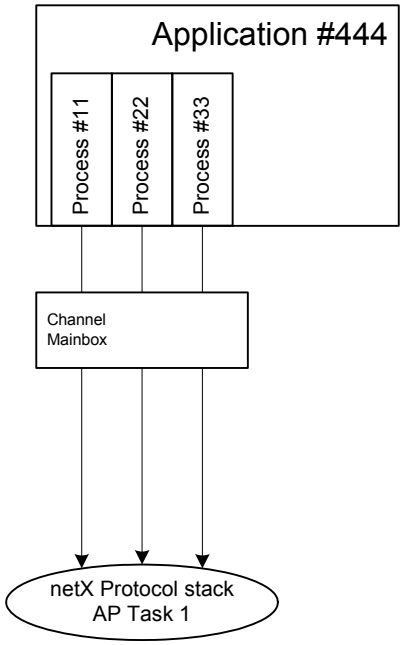

Figure 3: Using `ulSrc` *and* `ulSrcId`

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Example:

This example applies to command messages initiated by a process in the context of the host application. If the process #22 sends a packet through the channel mailbox to the AP task, the packet header has to be filled in as follows:

Object	Variable Name	Numeric Value	Explanation
Destination Queue Handle	`ulDest`	`= 32 (0x00000020)`	This value needs always to be set to 0x00000020 (the channel token) when accessing the protocol stack via the local communication channel mailbox.
Source Queue Handle	`ulSrc`	`= 444`	Denotes the host application (#444).
Destination Identifier	`ulDestId`	`= 0`	In this example it is not necessary to use the destination identifier.
Source Identifier	`ulSrcId`	`= 22`	Denotes the process number of the process within the host application and needs therefore to be supplied by the programmer of the host application.

Table 14: Using `ulSrc` *and* `ulSrcId`

For packets through the channel mailbox, the application uses 32 (= 0x20, *Channel Token*) for the destination queue handler *ulDest*. The source queue handler *ulSrc* and the source identifier *ulSrcId* are used to identify the originator of a packet. The destination identifier *ulDestId* can be used to address certain resources in the protocol stack. It is not used in this example. The source queue handler *ulSrc* has to be filled in. Therefore its use is mandatory; the use of *ulSrcId* is optional.

The netX operating system passes the request packet to the protocol stack's AP task. The protocol stack then builds a reply to the packet and returns it to the mailbox. The application has to make sure that the packet finds its way back to the originator (process #22 in the example).

2.3.2.3 How to Route rcX Packets

To route an rcX packet the source identifier *ulSrcId* and the source queues handler *ulSrc* in the packet header hold the identification of the originating process. The router saves the original handle from *ulSrcId* and *ulSrc*. The router uses a handle of its own choices for *ulSrcId* and *ulSrc* before it sends the packet to the receiving process. That way the router can identify the corresponding reply packet and matches the handle from that packet with the one stored earlier. Now the router replaces its handles with the original handles and returns the packet to the originating process.

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2.3.3 Obtaining useful Information about the Communication Channel

A communication channel represents a part of the Dual Port Memory and usually consists of the following elements:

- **Output Data Image**
  is used to transfer cyclic process data to the network (normal or high-priority)
- **Input Data Image**
  is used to transfer cyclic process data from the network (normal or high-priority)
- **Send Mailbox**
  is used to transfer non-cyclic data to the netX
- **Receive Mailbox**
  is used to transfer non-cyclic data from the netX
- **Control Block**
  allows the host system to control certain channel functions
- **Common Status Block**
  holds information common to all protocol stacks
- **Extended Status Block**
  holds protocol specific network status information

This section describes a procedure how to obtain useful information for accessing the communication channel(s) of your netX device and to check if it is ready for correct operation.

Proceed as follows:

1) Start with reading the channel information block within the system channel (usually starting at address `0x0030`).
2) Then you should check the hardware assembly options of your netX device. They are located within the system information block following offset `0x0010` and stored as data type `UINT16`. The following table explains the relationship between the offsets and the corresponding xC Ports of the netX device:

Offset	Port
`0x0010`	Hardware Assembly Options for xC Port[0]
`0x0012`	Hardware Assembly Options for xC Port[1]
`0x0014`	Hardware Assembly Options for xC Port[2]
`0x0016`	Hardware Assembly Options for xC Port[3]

Check each of the hardware assembly options whether its value has been set to `RCX_HW_ASSEMBLY_CAN = 0x0030`. If true, this denotes that this xCPort is suitable for running the CANopen protocol stack. Otherwise, this port is designed for another communication protocol. In most cases, xC Port[2] will be used for field-bus systems, while xC Port[0] and xC Port[1] are normally used for Ethernet communication.

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3) You can find information about the corresponding communication channel (0…3) under the following addresses:

Offset	Communication Channel
0x0050	Communication Channel 0
0x0060	Communication Channel 1
0x0070	Communication Channel 2
0x0080	Communication Channel 3

In devices which support only one communication system which is usually the case (either a single field-bus system or a single standard for Industrial-Ethernet communication), always communication channel 0 will be used. In devices supporting more than one communication system you should also check the other communication channels.

4) There you can find such information as the ID (containing channel number and port number) of the communication channel, the size and the location of the handshake cells, the overall number of blocks within the communication channel and the size of the channel in bytes. Evaluate this information precisely in order to access the communication channel correctly.

The information is delivered as follows:

Size of Channel in Bytes

Address	Data Type	Description
0x0050	UINT8	Channel Type = COMMUNICATION (must have the fixed value define RCX_CHANNEL_TYPE_COMMUNICATION = 0x05)
0x0051	UINT8	ID (Channel Number, Port Number)
0x0052	UINT8	Size / Position Of Handshake Cells
0x0053	UINT8	Total Number Of Blocks Of This Channel
0x0054	UINT32	Size Of Channel In Bytes
0x0058	UINT8[8]	Reserved (set to zero)

These addresses correspond to communication channel 0, for communication channels 1, 2 and 3 you have to add an offset of 0x0010, 0x0020 or 0x0030 to the address values, respectively.

5) Finally, you can access the communication channel using the addresses you determined previously. For more information how to do this, please refer to the netX DPM Manual, especially section 3.2 “Communication Channel".

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2.4 Client/Server Mechanism

2.4.1 Application as Client

The host application may send request packets to the netX firmware at any time (transition 1 ⇨ 2). Depending on the protocol stack running on the netX, parallel packets are not permitted (see protocol specific manual for details). The netX firmware sends a confirmation packet in return, signaling success or failure (transition 3 ⇨ 4) while processing the request.

The host application has to register with the netX firmware in order to receive indication packets (transition 5 ⇨ 6). Depending on the protocol stack, this is done either implicit (if application opens a TCP/UDP socket) or explicit (if application wants to receive unsolicited packets). Details on when and how to register for certain events is described in the protocol specific manual. Depending on the command code of the indication packet, a response packet to the netX firmware may or may not be required (transition 7 ⇨ 8).

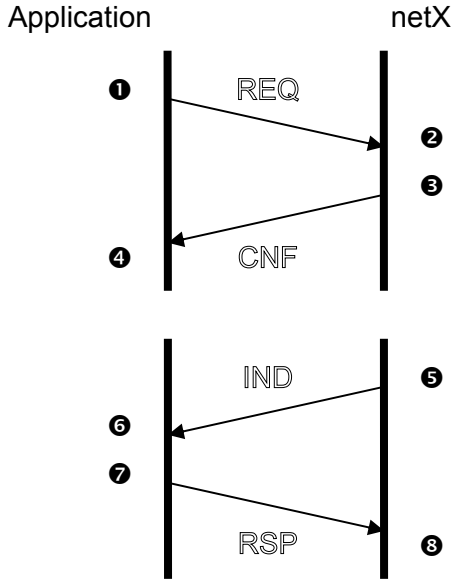

Figure 4: Transition Chart Application as Client

❶ ❷ *The host application sends request packets to the netX firmware.*

❸ ❹ The netX firmware sends a confirmation packet in return.

❺ ❻ The host application receives indication packets from the netX firmware.

❼ ❽ The host application sends response packet to the netX firmware (may not be required).

REQ Request CNF Confirmation

IND Indication RSP Response

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2.4.2 Application as Server

The host application has to register with the netX firmware in order to receive indication packets. Depending on the protocol stack, this is done either implicit (if application opens a TCP/UDP socket) or explicit (if application wants to receive unsolicited packets). Details on when and how to register for certain events is described in the protocol specific manual.

When an appropriate event occurs and the host application is registered to receive such a notification, the netX firmware passes an indication packet through the mailbox (transition 1 ⇨ 2). The host application is expected to send a response packet back to the netX firmware (transition 3 ⇨ 4).

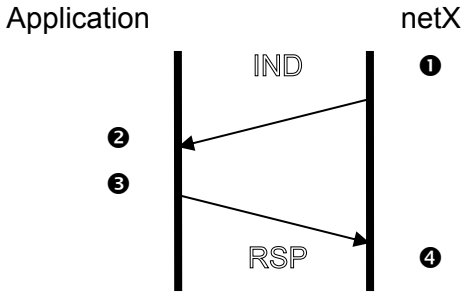

Figure 5: Transition Chart Application as Server

❶ ❷ The netX firmware passes an indication packet through the mailbox.

❸ ❹ The host application sends response packet to the netX firmware.

IND Indication RSP Response

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3 Dual-Port-Memory

All data in the dual-port memory is structured in blocks. According to their functions, these blocks use different data transfer mechanisms. For example, data transfer through mailboxes uses a synchronized handshake mechanism between host system and netX firmware. The same is true for IO data images, when a buffered handshake mode is configured. Other blocks, like the status block, are read by the host application and use no synchronization mechanism.

Types of blocks in the dual-port memory are outlined below:

- **Mailbox**
  transfer non-cyclic messages or packages with a header for routing information
- **Data Area**
  holds the process image for cyclic IO data or user defined data structures
- **Control Block**
  is used to signal application related state to the netX firmware
- **Status Block**
  holds information regarding the current network state
- **Change of State**
  collection of flags, that initiate execution of certain commands or signal a change of state

3.1 Cyclic Data (Input/Output Data)

The input block holds the process data image received **from** the network whereas the output block holds data sent **to** the network.

Process data transfer through the data blocks can be synchronized by using a handshake mechanism (configurable). If in uncontrolled mode, the protocol stack updates the process data in the input and output data image in the dual-port memory for each valid bus cycle. No handshake bits are evaluated and no buffers are used. The application can read or write process data at any given time without obeying the synchronization mechanism otherwise carried out via handshake location. This transfer mechanism is the simplest method of transferring process data between the protocol stack and the application. This mode can only guarantee data consistency over a byte.

For the controlled / buffered mode, the protocol stack updates the process data in the internal input buffer for each valid bus cycle. Each IO block uses handshake bits for access synchronization. Input and output data block handshake operates independently from each other. When the application toggles the input handshake bit, the protocol stack copies the data from the internal buffer into the input data image of the dual-port memory. Now the application can copy data from the dual-port memory and then give control back to the protocol stack by toggling the appropriate input handshake bit. When the application/driver toggles the output handshake bit, the protocol stack copies the data from the output data image of the dual-port memory into the internal buffer. From there the data is transferred to the network. The protocol stack toggles the handshake bits back, indicating to the application that the transfer is finished and a new data exchange cycle may start. This mode guarantees data consistency over both input and output area.

3.1.1 Input Data Image

The input data block is used by field bus and industrial Ethernet protocols that utilize a cyclic data exchange mechanism. The input data image is used to transfer cyclic data **from** the network.

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The default size of the input data image is 5760 byte. An output and input data block may or may not be available in the dual-port memory. They are always available in the default memory map (see the netX Dual-Port Memory Manual).

Input Data Image			
Offset	**Type**	**Name**	**Description**
0x2680	UINT8	`abPd0Input[5760]`	Input Data Image Cyclic Data From The Network

Table 15: Input Data Image

For netX devices with 8 kByte Dual-port Memory, the size of the input data image is 1536 byte:

Input Data Image			
Offset	**Type**	**Name**	**Description**
0x1600	UINT8	`abPd0Input[1536]`	Input Data Image Cyclic Data From The Network

Table 16: Input Data Image for netX devices with 8 kByte Dual-port Memory

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3.1.2 Process Data Output

The output data block is used by field bus and industrial Ethernet protocols that utilize a cyclic data exchange mechanism. The output data Image is used to transfer cyclic data **to** the network.

The default size of the output data image is 5760 byte. An output data block may or may not be available in the dual-port memory. They are always available in the default memory map (see netX DPM Manual).

Output Data Image			
Offset	**Type**	**Name**	**Description**
0x1000	UINT8	`abPd0Output[5760]`	Output Data Image Cyclic Data To The Network

Table 17: Output Data Image

For netX devices with 8 kByte Dual-port Memory, the size of the output data image is 1536 byte:

Output Data Image			
Offset	**Type**	**Name**	**Description**
0x1000	UINT8	`abPd0Output[1536]`	Output Data Image Cyclic Data To The Network

Table 18: Output Data Image for netX devices with 8 kByte Dual-port Memory

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3.2 Acyclic Data (Mailboxes)

The mailbox of each communication channel has two areas that are used for non-cyclic message transfer.

- **Send Mailbox**

  Packet transfer from host system to firmware

- **Receive Mailbox**

  Packet transfer from firmware to host system

The send and receive mailbox areas are used by field bus protocols providing a non-cyclic data exchange mechanism. Another use of the mailbox system is to allow access to the firmware running on the netX chip itself for diagnostic and identification purposes. The send mailbox is used to transfer cyclic data **to** the network or **to** the firmware. The receive mailbox is used to transfer cyclic data **from** the network or **from** the firmware.

A send/receive mailbox may or may not be available in the communication channel. It depends on the function of the firmware whether or not a mailbox is needed. The location of the system mailbox and the channel mailbox is described in the netX DPM Interface Manual.

Note: Each mailbox can hold one packet at a time. The netX firmware stores packets that are not retrieved by the host application in a packet queue. This queue has limited space and may fill up so new packets maybe lost. To avoid these deadlock situations, it is strongly recommended to empty the mailbox frequently, even if packets are not expected by the host application. Unexpected command packets should be returned to the sender with an *Unknown Command* in the status field; unexpected reply messages can be discarded.

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3.2.1 General Structure of Messages or Packets for Non-Cyclic Data Exchange

The non-cyclic packets through the netX mailbox have the following structure:

Structure Information				
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	Structure Information			
	`ulDest`	UINT32		Destination Queue Handle
	`ulSrc`	UINT32		Source Queue Handle
	`ulDestId`	UINT32		Destination Queue Reference
	`ulSrcId`	UINT32		Source Queue Reference
	`ulLen`	UINT32		Packet Data Length (In Bytes)
	`ulId`	UINT32		Packet Identification As Unique Number
	`ulSta`	UINT32		Status / Error Code
	`ulCmd`	UINT32		Command / Response
	`ulExt`	UINT32		Reserved
	`ulRout`	UINT32		Routing Information
tData	Structure Information			
	…	…		User Data Specific To The Command

Table 19: General Structure of Messages or Packets for Non-Cyclic Data Exchange

Some of the fields are mandatory; some are conditional; others are optional. However, the size of a packet is always at least 10 double-words or 40 bytes. Depending on the command, a packet may or may not have a data field. If present, the content of the data field is specific to the command, respectively the reply.

Destination Queue Handler

The *ulDest* field identifies a task queue in the context of the netX firmware. The task queue represents the final receiver of the packet and is assigned to a protocol stack. The *ulDest* field has to be filled out in any case. Otherwise, the netX operating system cannot route the packet. This field is mandatory.

Source Queue Handler

The *ulSrc* field identifies the sender of the packet. In the context of the netX firmware (inter-task communication) this field holds the identifier of the sending task. Usually, a driver uses this field for its own handle, but it can hold any handle of the sending process. Using this field is mandatory. The receiving task does not evaluate this field and passes it back unchanged to the originator of the packet.

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Destination Identifier

The *ulDestId* field identifies the destination of an unsolicited packet from the netX firmware to the host system. It can hold any handle that helps to identify the receiver. Therefore, its use is mandatory for unsolicited packets. The receiver of unsolicited packets has to register for this.

Source Identifier

The *ulSrcId* field identifies the originator of a packet. This field is used by a host application, which passes a packet from an external process to an internal netX task. The *ulSrcId* field holds the handle of the external process. When netX operating system returns the packet, the application can identify the packet and returns it to the originating process. The receiving task on the netX does not evaluate this field and passes it back unchanged. For inter-task communication, this field is not used.

Length of Data Field

The *ulLen* field holds the size of the data field in bytes. It defines the total size of the packet's payload that follows the packet's header. The size of the header is not included in *ulLen*. So the total size of a packet is the size from *ulLen* plus the size of packet's header. Depending on the command, a data field may or may not be present in a packet. If no data field is included, the length field is set to zero.

Identifier

The *ulId* field is used to identify a specific packet among others of the same kind. That way the application or driver can match a specific reply or confirmation packet to a previous request packet.

The receiving task does not change this field and passes it back to the originator of the packet. Its use is optional in most of the cases. But it is mandatory for sequenced packets. Example: Downloading big amounts of data that does not fit into a single packet. For a sequence of packets the identifier field is incremented by one for every new packet.

Status / Error Code

The *ulState* field is used in response or confirmation packets. It informs the originator of the packet about success or failure of the execution of the command. The field may be also used to hold status information in a request packet.

Command / Response

The *ulCmd* field holds the command code or the response code, respectively. The command/response is specific to the receiving task. If a task is not able to execute certain commands, it will return the packet with an error indication. A command is always even (the least significant bit is zero). In the response packet, the command code is incremented by one indicating a confirmation to the request packet.

Extension

The extension field *ulExt* is used for controlling packets that are sent in a sequenced manner. The extension field indicates the first, last or a packet of a sequence. If sequencing is not required, the extension field is not used and set to zero.

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Routing Information

The *ulRout* field is used internally by the netX firmware only. It has no meaning to a driver type application and therefore set to zero.

User Data Field

This field contains data related to the command specified in *ulCmd* field. Depending on the command, a packet may or may not have a data field. The length of the data field is given in the *ulLen* field.

3.2.2 Status & Error Codes

The following status and error codes can be returned in `ulState`: List of codes see manual named *netX Dual-Port Memory Interface*.

3.2.3 Differences between System and Channel Mailboxes

The mailbox system on netX provides a non-cyclic data transfer channel for field bus and industrial Ethernet protocols. Another use of the mailbox is allowing access to the firmware running on the netX chip itself for diagnostic purposes. There is always a send and a receive mailbox. Send and receive mailboxes utilize handshake bits to synchronize these data or diagnostic packages through the mailbox. There is a pair of handshake bits for both the send and receive mailbox.

The netX operating system rcX only uses the system mailbox.

- The *system mailbox*, however, has a mechanism to route packets to a communication channel.
- A *channel mailbox* passes packets to its own protocol stack only.

3.2.4 Send Mailbox

The send mailbox area is used by protocols utilizing a non-cyclic data exchange mechanism. Another use of the mailbox system is to provide access to the firmware running on the netX chip itself. The **send** mailbox is used to transfer non-cyclic data **to** the network or **to** the protocol stack.

The size is 1596 bytes for the send mailbox in the default memory layout. The mailbox is accompanied by counters that hold the number of packages that can be accepted.

3.2.5 Receive Mailbox

The receive mailbox area is used by protocols utilizing a non-cyclic data exchange mechanism. Another use of the mailbox system is to provide access to the firmware running on the netX chip itself. The **receive** mailbox is used to transfer non-cyclic data **from** the network or **from** the protocol stack.

The size is 1596 bytes for the receive mailbox in the default memory layout. The mailbox is accompanied by counters that hold the number of waiting packages (for the receive mailbox).

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3.2.6 Channel Mailboxes (Details of Send and Receive Mailboxes)

Master Status			
Offset	**Type**	**Name**	**Description**
0x0200	UINT16	`usPackagesAccepted`	Packages Accepted Number of Packages that can be Accepted
0x0202	UINT16	`usReserved`	Reserved Set to 0
0x0204	UINT8[]	`abSendMbx[1596]`	Send Mailbox Non Cyclic Data To The Network or to the Protocol Stack
0x0840	UINT16	`usWaitingPackages`	Packages waiting Counter of packages that are waiting to be processed
0x0842	UINT16	`usReserved`	Reserved Set to 0
0x0844	UINT8	`abRecvMbx[1596]`	Receive Mailbox Non Cyclic Data **from** the network or **from** the protocol stack

Table 20: Channel Mailboxes

Channel Mailboxes Structure

```
typedef struct tagNETX_SEND_MAILBOX_BLOCK
{
UINT16 usPackagesAccepted;
UINT16 usReserved;
UINT8 abSendMbx[1596];
} NETX_SEND_MAILBOX_BLOCK;
typedef struct tagNETX_RECV_MAILBOX_BLOCK
{
UINT16 usWaitingPackages;
UINT16 usReserved;
UINT8 abRecvMbx[1596];
}NETX_RECV_MAILBOX_BLOCK;
```


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3.3 Status

A status block is present within the communication channel. It contains information about network and task related issues. In some respects, status and control block are used together in order to exchange information between host application and netX firmware. The application reads a status block whereas the control block is written by the application. Both status and control block have registers that use the *Change of State* mechanism (see also section 2.2.1 of the *netX Dual-Port-Memory manual*).

3.3.1 Common Status

The Common Status Block contains information that is the same for all communication channels. The start offset of this block depends on the size and location of the preceding blocks. The status block is always present in the dual-port memory.

3.3.1.1 All Implementations

The structure outlined below is common to all protocol stacks.

Common Status Structure Definition

Common Status			
Offset	**Type**	**Name**	**Description**
0x0010	UINT32	`ulCommunicationCOS`	Communication Change of State READY, RUN, RESET REQUIRED, NEW, CONFIG AVAILABLE, CONFIG LOCKED
0x0014	UINT32	`ulCommunicationState`	Communication State NOT CONFIGURED, STOP, IDLE, OPERATE
0x0018	UINT32	`ulCommunicationError`	Communication Error Unique Error Number According to Protocol Stack
0x001C	UINT16	`usVersion`	Version Version Number of this Diagnosis Structure
0x001E	UINT16	`usWatchdogTime`	Watchdog Timeout Configured Watchdog Time
0x0020	UINT16	`usHandshakeMode`	Handshake Mode Process Data Transfer Mode (see netX DPM Interface Manual)
0x0022	UINT16	`usReserved`	Reserved Set to 0
0x0024	UINT32	`ulHostWatchdog`	Host Watchdog Joint Supervision Mechanism Protocol Stack Writes, Host System Reads

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0x0028	UINT32	ulErrorCount	Error Count Total Number of Detected Errors Since Power-Up or Reset
0x002C	UINT32	ulErrorLoglnd	Error Log Indicator Total Number Of Entries In The Error Log Structure (not supported yet)
0x0030	UINT32	ulReserved[2]	Reserved Set to 0

Table 21: Common Status Structure Definition

Common Status Block Structure Reference

```
typedef struct NETX_COMMON_STATUS_BLOCK_Ttag
{
  UINT32   ulCommunicationCOS;
  UINT32   ulCommunicationState;
  UINT32   ulCommunicationError;
  UINT16   usVersion;
  UINT16   usWatchdogTime;
  UINT16   ausReserved[2];
  UINT32   ulHostWatchdog;
  UINT32   ulErrorCount;
  UINT32   ulErrorLogInd;
  UINT32   ulReserved[2];
  union
  {
    NETX_MASTER_STATUS_T  tMasterStatus;    /* for master implementation */
    UINT32                aulReserved[6];   /* otherwise reserved        */
  } unStackDepended;
} NETX_COMMON_STATUS_BLOCK_T;
```

Communication Change of State (All Implementations)

The communication change of state register contains information about the current operating status of the communication channel and its firmware. Every time the status changes, the netX protocol stack toggles the n*etX Change of State Command* flag in the netX communication flags register (see section 3.2.2.1 of the netX DPM Interface Manual). The application then has to toggle the *netX Change of State Acknowledge* flag back acknowledging the new state (see section 3.2.2.2 of the netX DPM Interface Manual).

ulCommunicationCOS - netX writes, Host reads		
Bit	**Short name**	**Name**
D31 .. D7	**unused, set to zero**	
D6	Restart Required Enable	RCX_COMM_COS_RESTART_REQUIRED_ENABLE
D5	Restart Required	RCX_COMM_COS_RESTART_REQUIRED
D4	Configuration New	RCX_COMM_COS_CONFIG_NEW
D3	Configuration Locked	RCX_COMM_COS_CONFIG_LOCKED
D2	Bus On	RCX_COMM_COS_BUS_ON
D1	Running	RCX_COMM_COS_RUN
D0	Ready	RCX_COMM_COS_READY

Table 22: Communication State of Change

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Communication Change of State Flags (netX System ⇨ Application)

Bit	Definition / Description
0	Ready (RCX_COMM_COS_READY) 0 - … 1 - The *Ready* flag is set as soon as the protocol stack is started properly. Then the protocol stack is awaiting a configuration. As soon as the protocol stack is configured properly, the *Running* flag is set, too.
1	Running (RCX_COMM_COS_RUN) 0 - … 1 -The *Running* flag is set when the protocol stack has been configured properly. Then the protocol stack is awaiting a network connection. Now both the *Ready* flag and the *Running* flag are set.
2	Bus On (RCX_COMM_COS_BUS_ON) 0 - … 1 -The *Bus On* flag is set to indicate to the host system whether or not the protocol stack has the permission to open network connections. If set, the protocol stack has the permission to communicate on the network; if cleared, the permission was denied and the protocol stack will not open network connections.
3	Configuration Locked (RCX_COMM_COS_CONFIG_LOCKED) 0 - … 1 -The *Configuration Locked* flag is set, if the communication channel firmware has locked the configuration database against being overwritten. Re-initializing the channel is not allowed in this state. To unlock the database, the application has to clear the *Lock Configuration* flag in the control block (see section 3.2.4 of the netX DPM Interface Manual).
4	Configuration New (RCX_COMM_COS_CONFIG_NEW) 0 - … 1 -The *Configuration New* flag is set by the protocol stack to indicate that a new configuration became available, which has not been activated. This flag may be set together with the *Restart Required* flag.
5	Restart Required (RCX_COMM_COS_RESTART_REQUIRED) 0 - … 1 -The *Restart Required* flag is set when the channel firmware requests to be restarted. This flag is used together with the *Restart Required Enable* flag below. Restarting the channel firmware may become necessary, if a new configuration was downloaded from the host application or if a configuration upload via the network took place.
6	Restart Required Enable (RCX_COMM_COS_RESTART_REQUIRED_ENABLE) 0 - … 1 - The *Restart Required Enable* flag is used together with the *Restart Required* flag above. If set, this flag enables the execution of the Restart Required command in the netX firmware (for details on the *Enable* mechanism see section 2.3.2 of the netX DPM Interface Manual)).
7 … 31	Reserved, set to 0

Table 23: Meaning of Communication Change of State Flags

Other values are reserved.

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Communication State (All Implementations)

The communication state field contains information regarding the current network status of the communication channel. Depending on the implementation, all or a subset of the definitions below is supported.

- UNKNOWN #define RCX_COMM_STATE_UNKNOWN 0x00000000
- NOT_CONFIGURED #define RCX_COMM_STATE_NOT_CONFIGURED 0x00000001
- STOP #define RCX_COMM_STATE_STOP 0x00000002
- IDLE #define RCX_COMM_STATE_IDLE 0x00000003
- OPERATE #define RCX_COMM_STATE_OPERATE 0x00000004
- If the CANopen Slave V3 Protocol Stack is in state PRE-OPERATIONAL, the communication state is set to IDLE.
- If the CANopen Slave V3 Protocol Stack is in state STOPPED, the communication state is set to STOP.

Communication Channel Error (All Implementations)

This field holds the current error code of the communication channel. If the cause of error is resolved, the communication error field is set to zero (= RCX_SYS_SUCCESS) again. Not all of the error codes are supported in every implementation. Protocol stacks may use a subset of the error codes below.

- SUCCESS #define RCX_SYS_SUCCESS 0x00000000

Runtime Failures

- WATCHDOG TIMEOUT #define RCX_E_WATCHDOG_TIMEOUT 0xC000000C

Initialization Failures

- (General) INITIALIZATION FAULT
  `#define RCX_E_INIT_FAULT 0xC0000100`
- DATABASE ACCESS FAILED #define RCX_E_DATABASE_ACCESS_FAILED 0xC0000101

Configuration Failures

- NOT CONFIGURED #define RCX_E_NOT_CONFIGURED 0xC0000119
- (General) CONFIGURATION FAULT
  #define RCX_E_CONFIGURATION_FAULT 0xC0000120
- INCONSISTENT DATA SET #define RCX_E_INCONSISTENT_DATA_SET 0xC0000121
- DATA SET MISMATCH #define RCX_E_DATA_SET_MISMATCH 0xC0000122
- INSUFFICIENT LICENSE #define RCX_E_INSUFFICIENT_LICENSE 0xC0000123
- PARAMETER ERROR #define RCX_E_PARAMETER_ERROR 0xC0000124
- INVALID NETWORK ADDRESS #define RCX_E_INVALID_NETWORK_ADDRESS 0xC0000125
- NO SECURITY MEMORY#define RCX_E_NO_SECURITY_MEMORY 0xC0000126

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Network Failures

- (General) NETWORK FAULT #define RCX_COMM_NETWORK_FAULT 0xC0000140
- CONNECTION CLOSED #define RCX_COMM_CONNECTION_CLOSED 0xC0000141
- CONNECTION TIMED OUT #define RCX_COMM_CONNECTION_TIMEOUT 0xC0000142
- LONELY NETWORK #define RCX_COMM_LONELY_NETWORK 0xC0000143
- DUPLICATE NODE #define RCX_COMM_DUPLICATE_NODE 0xC0000144
- CABLE DISCONNECT #define RCX_COMM_CABLE_DISCONNECT 0xC0000145

Version (All Implementations)

The version field holds version of this structure. It starts with one; zero is not defined.

- STRUCTURE VERSION #define RCX_STATUS_BLOCK_VERSION 0x0001

Watchdog Timeout (All Implementations)

This field holds the configured watchdog timeout value in milliseconds. The application may set its watchdog trigger interval accordingly. If the application fails to copy the value from the host watchdog location to the device watchdog location, the protocol stack will interrupt all network connections immediately regardless of their current state. For details, see section 4.13 of the netX DPM Interface Manual.

Host Watchdog (All Implementations)

The protocol stack supervises the host system using the watchdog function. If the application fails to copy the value from the device watchdog location (section 3.2.5 of the netX DPM Interface Manual) to the host watchdog location (section 3.2.4 of the netX DPM Interface Manual), the protocol stack assumes that the host system has some sort of problem and shuts down all network connections. For details on the watchdog function, refer to section 4.13 of the netX DPM Interface Manual.

Error Count (All Implementations)

This field holds the total number of errors detected since power-up, respectively after reset. The protocol stack counts all sorts of errors in this field no matter if they were network related or caused internally.

Error Log Indicator (All Implementations)

The error log indicator field holds the number of entries in the internal error log. If all entries are read from the log, the field is set to zero. The error log indicator is not supported yet.

3.3.1.2 Master Implementation

The master contains additional structures for the administration of all slaves which are connected to the master. These are not discussed here as they are not relevant for the slave.

3.3.1.3 Slave Implementation

The slave firmware uses only the common structure as outlined in section 3.2.5.1 of the Hilscher netX Dual-Port-Memory Manual.

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3.3.2 Extended Status

The content of the channel specific extended status block is specific to the implementation. Depending on the protocol, a status area may or may not be present in the dual-port memory. It is always available in the default memory map (see section 3.2.1 of netX Dual-Port Memory Manual).

Note: Have in mind, that all offsets mentioned in this section are relative to the beginning of the common status block, as the start offset of this block depends on the size and location of the preceding blocks.

Extended Status Block			
Offset	**Type**	**Name**	**Description**
0x0050	UINT8[ ]	`abExtendedStatus[432]`	Extended Status Area Protocol Stack Specific Status Area

Table 24: Extended Status Block (General Structure)

Extended Status Block Structure

```
typedef struct CANOPEN_SLAVE_EXTENDED_STATE_Ttag
  CANOPEN_SLAVE_EXTENDED_STATE_T;

#define CANOPEN_SLAVE_EXT_STATE_FLAG_CAN_INIT     0x00000001L
#define CANOPEN_SLAVE_EXT_STATE_FLAG_CAN_ACTIVE   0x00000002L
#define CANOPEN_SLAVE_EXT_STATE_FLAG_PASSIVE      0x00000004L
#define CANOPEN_SLAVE_EXT_STATE_FLAG_BUS_OFF      0x00000008L
#define CANOPEN_SLAVE_EXT_STATE_FLAG_RX_OVERFLOW  0x00000010L
#define CANOPEN_SLAVE_EXT_STATE_FLAG_TX_OVERFLOW  0x00000020L
#define CANOPEN_SLAVE_EXT_STATE_FLAG_WDG          0x00000100L
#define CANOPEN_SLAVE_EXT_STATE_CTRL              0x00001000L
#define CANOPEN_SLAVE_EXT_STATE_NRDY              0x00002000L
#define CANOPEN_SLAVE_EXT_STATE_TIMEOUT           0x00004000L

#define CANOPEN_SLAVE_EXT_STATE_UNKNOWN           0x00000000L
#define CANOPEN_SLAVE_EXT_STATE_OPERATIONAL       0x00000001L
#define CANOPEN_SLAVE_EXT_STATE_STOP              0x00000002L
#define CANOPEN_SLAVE_EXT_STATE_PRE_OPERATIONAL   0x00000080L
#define CANOPEN_SLAVE_EXT_STATE_INITIALISING      0x000000FFL

#define CANOPEN_SLAVE_ADD_DETAIL_SIZE             0x00000003L

struct CANOPEN_SLAVE_EXTENDED_STATE_Ttag
{
  TLR_UINT32 ulFlags;
  TLR_UINT32 ulNodeState;
  TLR_UINT32 ulBusOffEveCnt;
  TLR_UINT32 ulErrorPassiveEveCnt;
  TLR_UINT32 ulRxOverflowCnt;
  TLR_UINT32 ulTxOverflowCnt;
  TLR_UINT32 ulReserved;
  TLR_UINT32 ulTimeoutCnt;

  TLR_UINT32 aulReserved[4];

  TLR_UINT32 ulDiagInfoCount;
  TLR_UINT32 ulLastDiagInfo;
  TLR_UINT32 ulMaxRecvIdx;
  TLR_UINT32 ulMaxSendIdx;
  TLR_UINT32 aulAddDetail[CANOPEN_SLAVE_ADD_DETAIL_SIZE];
};
```


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3.3.2.1 Extended Status Block

Additional Info Block for CANopen Slave			
Offset	**Type**	**Name**	**Description**
0x50	unsigned long	ulFlags	Bit field for Flags
0x54	unsigned long	ulNodeState	Current Node State
0x58	unsigned long	ulBusOffEveCnt	Counter for bus off events
0x5C	unsigned long	ulErrorPassiveEveCnt	Counter for passive event errors
0x60	unsigned long	ulRxOverflowCnt	Counter for receive overflows
0x64	unsigned long	ulTxOverflowCnt	Counter for transmit overflows
0x68	unsigned long	ulErrorWarningCnt	Count of errors and Warnings
0x6C	unsigned long	ulTimeoutCnt	Number of timeouts
0x70	unsigned long[]	aulReserved[3]	Reserved for further use
0x7C	unsigned long	ulIndLostCnt	Count of Lost Indications
0x80	unsigned long	ulDiagInfoCount	Number of diagnostic entries
0x84	unsigned long	ulLastDiagInfo	Last diagnostic entry
0x88	unsigned long	ulMaxRecvIdx	Maximum Object Index Value for Receive Data
0x8C	unsigned long	ulMaxSendIdx	Maximum Object Index Value for Send Data
0x90	unsigned long[]	aulAddDetail[3]	Additional detail for diagnostic entry

Table 25: Additional Info Block

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ulFlags

This variable is organized as a bit field as described in the table below:

Bit	Name	Description
D31.. D17	**Reserved**	Reserved for further use
D16	**CANOPEN_SLAVE_EXT_STATE_ FLAG_WARNING**	A warning has been issued
D15	**Reserved**	Reserved for further use
D14	**CANOPEN_SLAVE_EXT_STATE_ TIMEOUT**	The DEVICE has detected an overstepped timeout supervision time of at least one CAN message to be sent. The transmission of this message was aborted. The data is lost. Its an indication that no other CAN device was connected or responsive at this time to acknowledge the sent message requests. The bit will be set when the first timeout was detected and will not be deleted any more.
D13	**CANOPEN_SLAVE_EXT_STATE_ NRDY**	Indicates if the HOST program has set its state to operative or not. If the bit is set the HOST program is not ready to communicate.
D12	**CANOPEN_SLAVE_EXT_STATE_ CTRL**	Parameterization error or severe run time error
D11.. D10	**Reserved**	Reserved for further use
D9	**CANOPEN_SLAVE_EXT_STATE_ FLAG_SLAVE_ERROR**	An error has been issued from the slave
D8	**CANOPEN_SLAVE_EXT_STATE_ FLAG_WDG**	Watchdog error detected
D7	**Reserved**	Reserved for further use
D6	**CANOPEN_SLAVE_EXT_STATE_ FLAG_IND_LOST**	Indication has been lost
D5	**CANOPEN_SLAVE_EXT_STATE_ FLAG_TX_OVERFLOW**	Transmit overflow detected
D4	**CANOPEN_SLAVE_EXT_STATE_ FLAG_RX_OVERFLOW**	Receive overflow detected
D3	**CANOPEN_SLAVE_EXT_STATE_ FLAG_BUS_OFF**	CAN is in Bus-off state
D2	**CANOPEN_SLAVE_EXT_STATE_ FLAG_PASSIVE**	CAN is in error passive state
D1	**CANOPEN_SLAVE_EXT_STATE_ FLAG_CAN_ACTIVE**	CAN is activated
D0	**CANOPEN_SLAVE_EXT_STATE_ FLAG_CAN_INIT**	CAN is initialized

Table 26: Additional Info Flags

ulNodeState

Internal node state of node:

0: Unknown state

1: Operational state

2: Stop

128: Pre-operational state

255: Initializing

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ulBusOffEveCnt

Number of Bus-off events

ulErrorPassiveEveCnt

Number of error passive events

ulRxOverflowCnt

Number of receive overrun events

ulTxOverflowCnt

Number of transmit overrun events

ulErrorWarningCnt

Total count of errors and warnings

ulTimeoutCnt

Each CAN message is supervised by the card to be sent during 20ms by the CAN chip. If not possible, because the chip for example gets no acknowledging partner on the bus, this counter is incremented by one.

aulReserved[ ]

Reserved for further use

ulIndLostCnt

Count of lost indications

ulDiagInfoCount

Number of diagnostic entries

ulLastDiagInfo

Last diagnostic entry

ulMaxRecvIdx

Number of highest PDO mapped receive object index

ulMaxSendIdx

Number of highest PDO mapped send object index

aulAddDetail[ ]

Additional detail for diagnostic entry

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3.4 Control Block

A control block is always present in both system and communication channel. In some respects, control and status block are used together in order to exchange information between host application and netX firmware. The control block is written by the application, whereas the application reads a status block. Both control and status block have registers that use the *Change of State* mechanism (see section 0).

The following gives an example of the use of control and status block. The host application wishes to lock the configuration settings of a communication channel to protect them against changes. The application sets the *Lock Configuration* flag in the control block to the communication channel firmware. As a result, the channel firmware sets the *Configuration Locked* flag in the status block (see below), indicating that the current configuration settings cannot be deleted, altered, overwritten or otherwise changed.

The control block of a dual-port memory features a watchdog function to allow the operating system running on the netX supervise the host application and vice versa. The control area is always present in the dual-port memory.

Control Block			
Offset	**Type**	**Name**	**Description**
0x0008	UINT32	`ulApplicationCOS`	Application Change Of State State Of The Application Program INITIALIZATION, LOCK CONFIGURATION
0x000C	UINT32	`ulDeviceWatchdog`	Device Watchdog Host System Writes, Protocol Stack Reads

Table 27: Communication Control Block

Communication Control Block Structure

```
typedef struct NETX_CONTROL_BLOCK_Ttag
{
UINT32 ulApplicationCOS;
UINT32 ulDeviceWatchdog;
} NETX_CONTROL_BLOCK_T;
```

For more information concerning the control block please refer to the netX DPM Interface Manual**.**

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4 Getting Started

4.1 Overview about Essential Functionality

You can find the most commonly used functionality of the CANopen slave API within the following sections of this document:

Topic	Section Number	Section Name
Process (PDO) data transfer (Input/Output)	5.2.12	CANOPEN_SLAVE_SEND_TXPDO_REQ – Send TxPDO Request
Emergency Handling	5.2.6	CANOPEN_SLAVE_SEND_EMCY_REQ/CNF – Send Emergency Message

Table 28: Overview about essential Functionality (Cyclic and acyclic Data Transfer and Alarm Handling).

4.2 Configuration Parameters and Procedures

The following ways are available to configure the CANopen Slave:

- By ‘Set Configuration’ packet
- By SYCON.net (only applicable in *Standard Mode*)
- By netX configuration tool (only applicable in *Standard Mode*)

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4.2.1 Using a Packet (CANOPEN_APS_SET_CONFIGURATION_REQ/CNF)

The following table contains relevant information about the configuration parameters for the CANopen Slave firmware such as an explanation of the meaning of the parameter and ranges of allowed values:

Parameter	Meaning	Range of Value / Value
Bus Startup	The start of the device can be performed either application controlled or automatically: ▪ Automatic: (not available in *Extended Mode*) ▪ Network connections are opened automatically without taking care of the state of the host application. ▪ Application controlled: ▪ The channel firmware is forced to wait for the host application to set the Application Ready flag in the communication change of state register (see section 3.2.5.1 of the *netX DPM Interface Manual*). For more information concerning this topic see section 4.4.1 “Controlled or Automatic Start” of the *netX DPM Interface Manual*.	Application controlled (1), Automatic (0) Default: Automatic (0)
I/O Status **(not yet supported)**	This parameter is represented by bits 1 and 2 of the system flags. Using this parameter you can set the status of the input or the output data. For each input and output date the following status information (in byte) is stored in the dual-port memory. The bits have the following meaning: Bit 1 (I/O Status Enable): 0 = Status disabled 1 = Status enabled **(not yet supported)** Bit 2 (I/O Status 8/32Bit): 0 = 1 Byte mode **(not yet supported)** 1 = 4 Byte mode **(not yet supported)** BIT 3 - 31: Reserved for further use, set to zero	
Address Switch	This parameter is represented by bit 4 of the system flags. It must be set when hardware address switch is used and there is no TAG present.	0 (off),1 (on)
Baudrate Switch	This parameter is represented by bit 5 of the system flags. It must be set when hardware baudrate switch is used and there is no TAG present.	0 (off),1 (on)
Watchdog Time [ms]	Watchdog time within which the device watchdog must be retriggered from the application program while the application program monitoring is activated. When the watchdog time value is equal to 0 respectively the application program monitoring is deactivated.	[0, 20 … 65535] ms, 0 = Off
Node ID	Node ID of CANopen slave	Allowed values: 1 .. 127

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Baudrate	Baud rate of CANopen connection. See below!	Allowed values: all baud rates offered in *Table 46: Codes and Corresponding Baud Rates of CANopen Network*.
Flags	CANopen Flags BIT 0: 29-BIT IDENTIFIER DISABLED/ ENABLED Not supported yet, set to zero BIT 1- 3: Reserved for further use, set to zero (BIT4 up to BIT10 are only applicable in Standard Mode) BIT 4: Evaluate Vendor ID DISABLED/ENABLED BIT 5: Evaluate Product Code DISABLED/ENABLED BIT 6: Evaluate Serial Number DISABLED/ENABLED BIT 7: Evaluate Revision Number DISABLED/ENABLED BIT 8: Evaluate Device Type DISABLED/ENABLED BIT 9: Evaluate Object Size DISABLED/ENABLED BIT 10: Evaluate PDO Count DISABLED/ENABLED BIT 11 - 15: Reserved for further use, set to zero BIT 16: Disable Send COS Synchronous Acyclic BIT 17: Disable Send COS Manufacturer Spec. BIT 18: Disable Send COS Profile Spec. BIT 19 - 24: Reserved for further use, set to zero BIT 25: Hold last state BIT 26 - 28: Reserved for further use, set to zero BIT 29: Extended Mode Flag BIT 30 - 32: Reserved for further use, set to zero	BIT 0: 29-BIT IDENTIFIER DISABLED/ ENABLED Not supported yet BIT 1 - 31: Reserved for further use, set to zero
Bus Parameters	This item either contains the standard parameters or the extended parameters. The standard parameters are described in *Table 36: Standard bus parameter structure CANOPEN_SLAVE_STD_BUSPARAM_DATA_T*. The extended parameters are described in *Table 39: Extended bus parameter structure CANOPEN_SLAVE_EXT_BUSPARAM_DATA_T*	
29 bit code	29 bit code for acceptance filtering	
29 bit mask	29 bit mask for acceptance filtering	

Table 29: Meaning and allowed Values for Configuration-Parameters.

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4.2.2 Behavior when receiving a Set Configuration Command

The following rules apply for the behaviour of the CANopen Slave protocol stack V3 when receiving a set configuration command:

- The configuration packets name is `CANOPEN_APS_SET_CONFIGURATION_REQ` for the request and `CANOPEN_APS_SET_CONFIGURATION_CNF` for the confirmation.
- The configuration data are checked for consistency and integrity.
- In case of failure no data are accepted.
- In case of success the configuration parameters are stored internally (within the RAM).
- The parameterized data will be activated only after a channel init has been performed.
- No automatic registration of the application at the stack happens.
- The confirmation packet `CANOPEN_APS_SET_CONFIGURATION_CNF` only transfers simple status information, but does not repeat the whole parameter set.
- A “Set Configuration Command” will not be processed in case of the protocol stack has already been configured via database prior to receiving this command.

4.3 Task Structure of the CANopen Slave V3 Stack

The illustration below displays the internal structure of the tasks which together represent the CANopen Slave Stack:

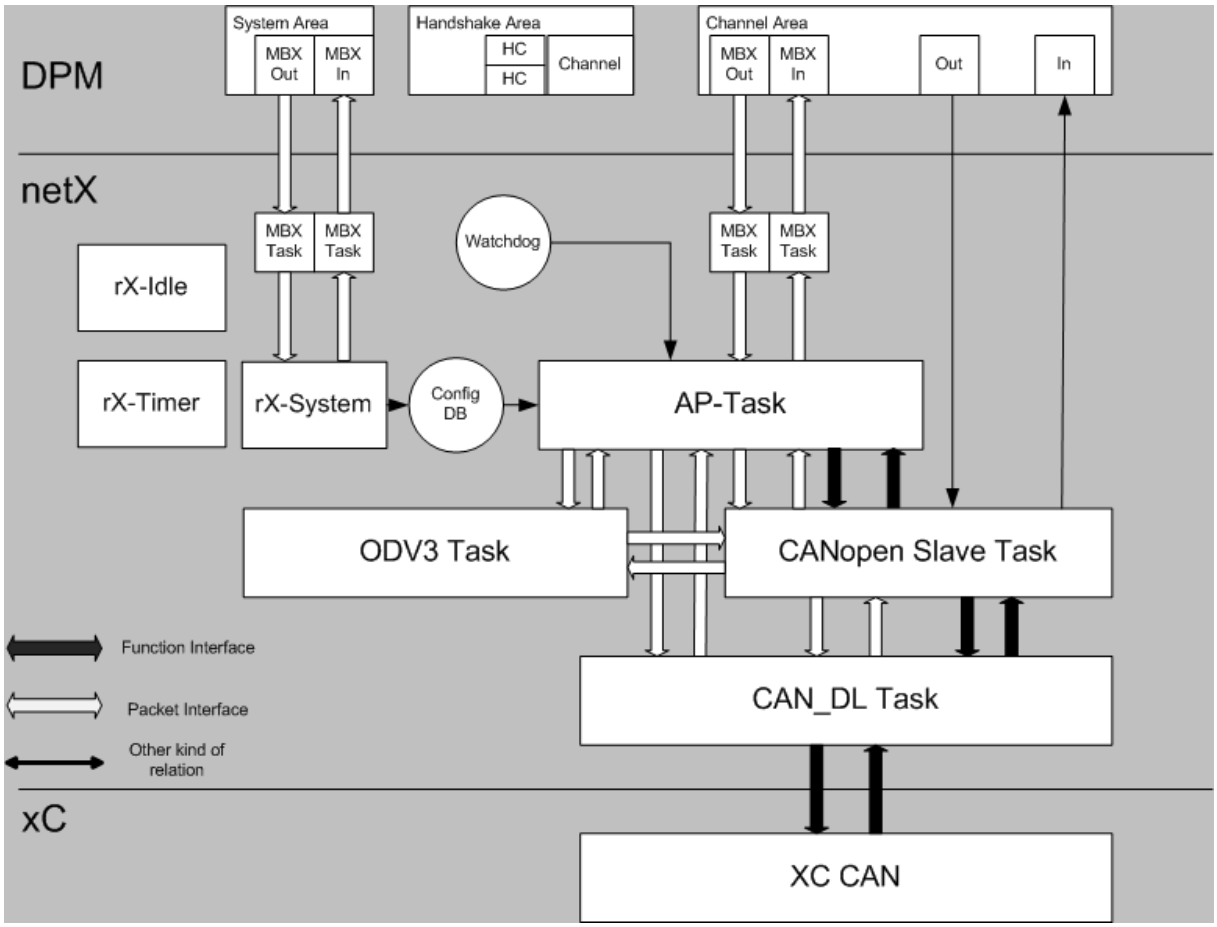

Figure 6: Internal Structure of CANopen Slave V3 Firmware

The dual-port memory is used for exchange of information, data and packets. Configuration and IO data will be transferred using this way.

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The user application only accesses the task located in the highest layer namely the AP task which constitutes the application interface of the CANopen Slave stack.

In detail, the various tasks have the following functionality and responsibilities:

AP-Task

The AP-Task provides the interface to the user application and the control of the stack. It also completely handles the Dual Port Memory interface of the communication channel. In detail, it is responsible for the following:

- - Handling the communication channels DPM-interface
- - Configuration of the protocol stack
- - IO Process data exchange
- - Channel mailboxes
- - Watchdog supervision
- - Handling of applications packets
- - Send/Receive packets

CANopen Slave Task

The CANopen Slave Task is the CANopen Slave stack implementation. It is responsible for the protocol handling, the communication to/from CAN_DL layer and it is the counterpart of the AP-Task.

The packets of the CANopen Slave task are described in section 5.1.2 “CANOPEN_APS_SET_CONFIGURATION_REQ/CNF – Set Configuration”

CAN_DL Task

The CAN_DL Task handles the interface of the XC CAN and is responsible for configuration, events and sending and receiving of CAN-Frames.

The CAN_DL Task also provides its own API for low-level programming on level 2 (Data Link Layer) of the OSI model of networking. This is described in a separate manual (namely reference [5]).

ODV3 Task

The ODV3 task handles all SDO accesses (i.e. acyclic accesses) to the CANopen object dictionary as described in the CANopen specification, section 9.5, p.79 (see reference [2]).

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4.4 CANopen – Basic Topics

4.4.1 NMT Slave State Machine

Each NMT Slave device implements the NMT Slave state machine. This state machine is displayed in *Figure 7: NMT Slave State Machine* below.

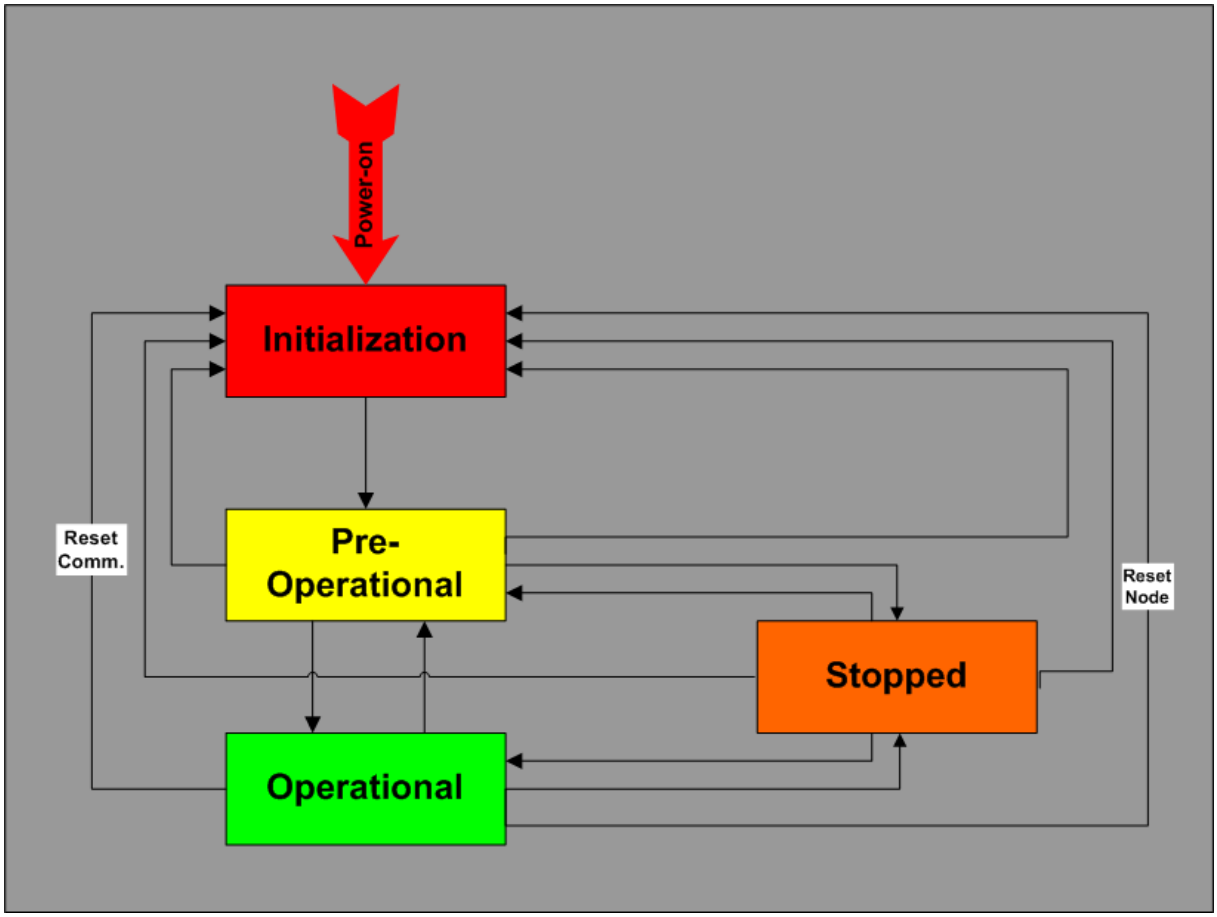

Figure 7: NMT Slave State Machine

After power-on or a reset (via `CANOPEN_SLAVE_INITIALIZE_REQ/CNF` – Initialization of CANopen Slave) and running through the initialization the state *Pre-operational* is reached automatically.

In *Pre-operational* state,

- No PDO communication is allowed
- SDO communication is allowed (this allows configuration and parameterization)

Switching from *Pre-operational* state to *Operational* state (and vice versa) is done by the NMT Master.

In *Operational* state,

- PDO communication is allowed
- SDO communication is allowed (Access to the Object Dictionary)

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In *Stopped* state,

- PDO communication is stopped
- SDO communication is stopped (No access to the Object Dictionary possible)
- Further services are also stopped (Time stamp, EMCY, SYNC).
- However, if active, Node Guarding or life-guarding will be continued.

The Initialization State can be subdivided into 3 sub-states in order to enable a complete or partial reset. This is illustrated by *Figure 8: Initialization State* below:

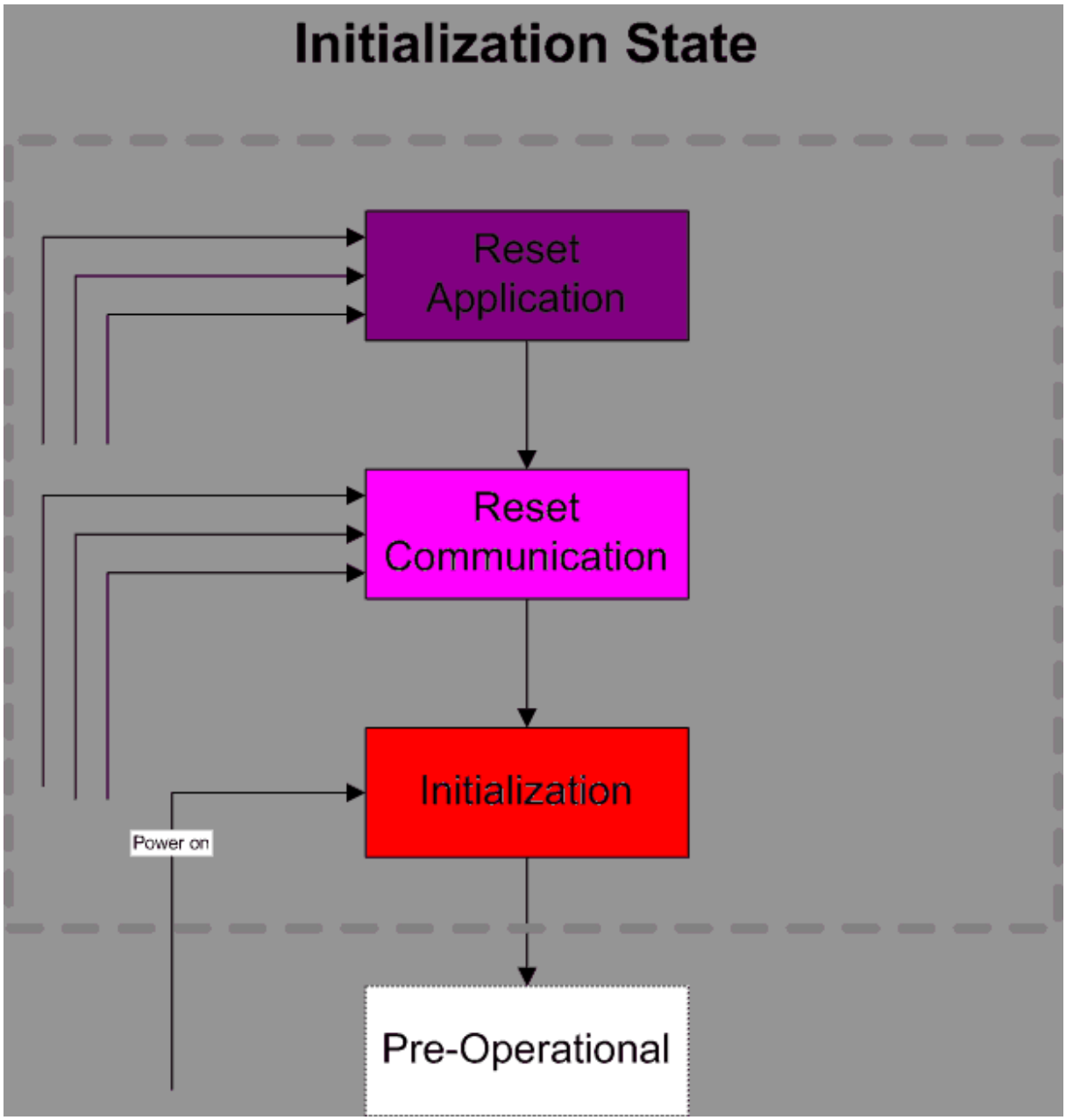

Figure 8: Initialization State of NMT Slave

The Initialization Sub-state (red rectangle in *Figure 8*) performs the basic initialization actions. After power-on, exactly this state is reached and automatically these actions are performed. When all actions are performed, the slave finally reaches the *Pre-operational* state.

The Reset Communication Sub-state provides the possibility to perform the basic device initialization. The parameters of the communication profile are set to their power-on values. After this has been finished, the slave switches to Initialization Sub-state and proceeds with the basic initialization actions.

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The Reset Application sub-state provides the possibility to perform the profile initialization. The parameters of the manufacturer-specific profile area and of the standardized device profile area are set to their power-on or default values. After this has been finished, the slave switches to Reset Communication Sub-state.

- The following mapping between the state of the CANopen Slave V3 State Machine and the communication status (0x14 in Common Status) is as follows:
- If the CANopen Slave V3 Protocol Stack is in state *Pre-operational*, the communication state is set to IDLE.
- If the CANopen Slave V3 Protocol Stack is in state *Stopped*, the communication state is set to STOP.
- If the CANopen Slave V3 Protocol Stack is in state *Operational*, the communication state is set to OPERATIONAL.

NMT also defines 5 services which allow changing the state to the states

- *Operational* (Service name: Start)
- *Stopped* (Service name: Stop)
- *Pre-operational* (Service name: Enter Pre-operational)

and the following two sub-states of state *Initialization*

- *Reset Application Sub-state* (Service name: Reset Node)
- *Reset Communication Sub-state* (Service name: Reset Communication)

See *Table 94: NMT States* on page 147 for more information concerning this topic.

The CANopen Slave protocol stack supports this with the following two packets:

- Packet `CANOPEN_SLAVE_SET_NMT_STATE_REQ/CNF` – Set NMT State allows your application to set the NMT state (and thus, to perform these 5 services mentioned above).
- Packet `CANOPEN_SLAVE_NMT_STATE_CHANGE_IND/RES` – NMT State Change Indication informs you whenever the NMT Master requests a state change and gives you the possibility to react appropriately.

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4.4.2 Communication Objects, COB-IDs and Priority of Processing

The CAN standard defines 2048 Communication Objects (COBs). A COB can contain at maximum 8 bytes of data. It represents a unit of data transportation in a CAN network. All data transport is done exclusively via COBs.

Communication Objects provide specific functionalities defined in the CANopen specification such as

- Process Data Objects
- Service Data Objects
- Synchronization Object
- Emergency Object
- Time-Stamp Object
- Boot-up Object
- Network Management Objects such as Node Guarding, Life-Guarding or Heartbeat Objects

which will be explained later on in this document

In order to uniquely identify the COBs within the CAN network, the available COBs are numbered from 0 to 2047. These 11 bit numbers uniquely identifying the COBs are called CAN identifiers. The CAN identifier of a COB is stored together with some bits (valid/invalid bit, remote frame support bit, frame format bit) as an object within the object dictionary. This object mainly containing the COB's CAN identifier is also called the COB-ID (i.e. COB-IDentifier). However, the term COB-ID is also often used for the single CAN identifier related to the COB. This manual also uses the term COB-ID in this sense.

The COB-ID plays an important role in CAN bus arbitration:(in the MAC layer): It determines the priority of processing for the COB. Lower values of the COB-ID mean higher priority.

4.4.2.1 Predefined Connection Set

The designer of a CANopen network must assign the COB-IDs to the various objects. He has a lot of freedom to do so. In order to easily setup smaller networks, there is a set of recommended and good running assignments provided by the specification: the predefined connection set. A factory new CANopen device will work with this predefined connection set when reaching the PRE-OPERATIONAL state for the first time (and, if no explicit changes have been stored, every time it reaches this state).

The predefined connection set works as follows:

The 11 bit CAN identifiers (COB-IDs) are separated in to a leading part of 4 bits denominated as the function code (Bits 10 to 7) and the trailing 7 bits (Bits 6 to 0) which represent the Node ID holding the addressing information within the CAN network.

The predefined connection set supports the following communication objects:

- 4 Receive-PDOs
- 4 Transmit-PDOs
- 1 SDO
- 1 Emergency Object
- and the NMT objects.

The following table shows which function codes (and thus ranges of COB-IDs) are assigned to which objects within the predefined connection set.

Additionally, it contains

- the index within the object dictionary where to adjust the communication parameters of that object

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- the information whether this object is a broadcast object (communication to all participants on the network) or a peer-to-peer object (communication between master and slave or slave and slave).

Object	Function code (binary notation)	Resulting Range of COB-IDs	Index of communication parameters	Broadcast/Peer-to-Peer
NMT	0000	0	-	Broadcast
SYNC	0001	128	0x1005—0x1007	Broadcast
EMERGENCY	0001	129-255	0x1014—0x1015	Peer-to-Peer
TIME STAMP	0010	256	0x1012—0x1013	Broadcast
PDO1(tx)	0011	385-511	0x1800	Peer-to-Peer
PDO1(rx)	0100	513-639	0x1400	Peer-to-Peer
PDO2(tx)	0101	641-767	0x1801	Peer-to-Peer
PDO2(rx)	0110	769-895	0x1401	Peer-to-Peer
PDO3(tx)	0111	897-1023	0x1802	Peer-to-Peer
PDO3(rx)	1000	1025-1151	0x1402	Peer-to-Peer
PDO4(tx)	1001	1153-1279	0x1803	Peer-to-Peer
PDO4(rx)	1010	1281-1407	0x1403	Peer-to-Peer
SDO (tx)	1011	1409-1535	0x1200	Peer-to-Peer
SDO (rx)	1100	1537-1663	0x1200	Peer-to-Peer
NMT Error Control	1110	1793-1919	0x1016—0x1017	Peer-to-Peer

Table 30: Objects of the Predefined Connection Set (seen from Point of View of the Device)

The following COB-IDs are restricted and may therefore not be used by all configurable COBs and by PDO, SDO, SYNC, TIME STAMP and EMCY:

COB-ID	Cause
0	Used by NMT Service, fixed assignment
1	Reserved
257-384	Reserved for Safety-relevant Data Objects (in CANopen Safety Framework)
1409-1535	Used by default SDO (tx) , fixed assignment
1537-1663	Used by default PDO (rx) , fixed assignment
1760	Reserved
1793-1919	Used by NMT Error Control, fixed assignment
2020-2047	Reserved

Table 31: COB-IDs with Restrictions of Use

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4.4.3 Relation between Communication Objects and NMT States

The following table provides the matrix which kinds of communication objects may exist during which states:

State / Object	INITIALISING	PRE-OPERATIONAL	OPERATIONAL	STOPPED
SDO				
SYNC				
TIME STAMP				
EMCY				
Boot-up object				
NMT objects				

- Green fields indicate the object may operate in this state.
- Red fields indicate the object cannot operate in this state.

4.4.4 Events

4.4.4.1 NMT State Change Events

NMT State Change Events happen every time the NMT Slave state changes. For a description of the NMT Slave State Machine, see section 4.4.1 *"NMT Slave State Machine"* on page 47.

Various reasons may have caused this change of NMT state:

- External request by the CANopen Master via NMT object for module control services. This is the most usual case.
- Internal request ; an application event initiated a module control service (for instance, a `CANOPEN_SLAVE_SET_NMT_STATE_REQ/CNF` – Set NMT State request.)
- A hardware reset occurred.

The NMT State Change Event is related to the following packets of the CANopen Slave protocol stack:

- `CANOPEN_SLAVE_SET_NMT_STATE_REQ/CNF` – Set NMT State for setting the state of the NMT Slave State Machine from your application.
- `CANOPEN_SLAVE_NMT_STATE_CHANGE_IND/RES` – NMT State Change Indication for making your application aware of state changes in the NMT Slave State Machine.
- `CANOPEN_SLAVE_NMT_COMMAND_IND/RES` – NMT Command Indication for enabling the host application to react to the requests for Module Control Services issued by the CANopen Master.

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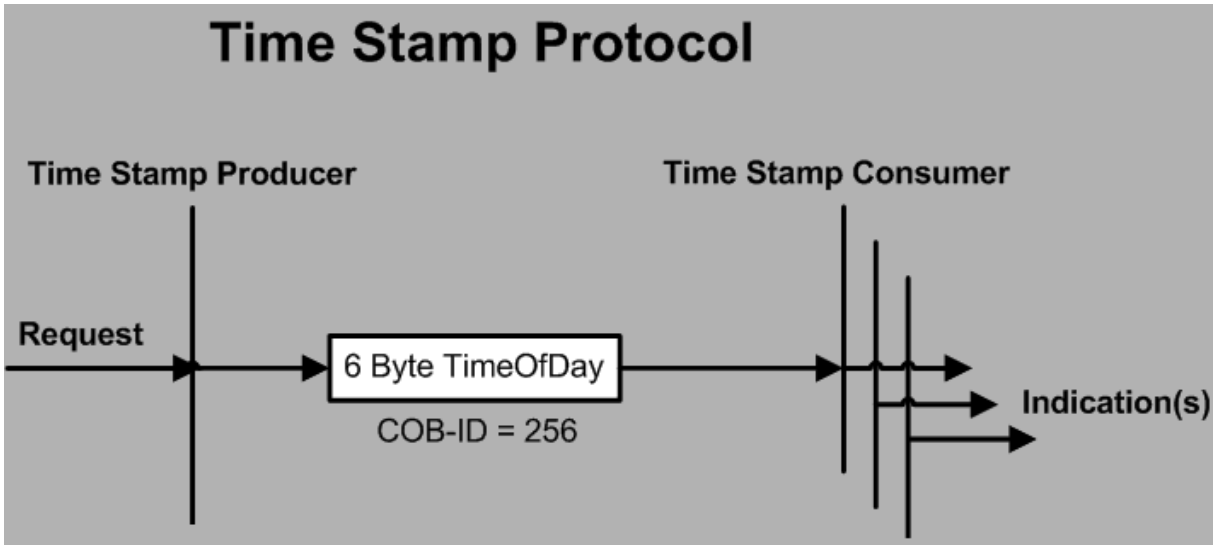
4.4.4.2 Time Stamp Events

The time stamp service allows to send time stamps from one node (CANopen Master or Slave) to another one. In terms of the Producer-Consumer-Model, a CANopen Slave can act (within a push model) both as a producer and as a consumer,

In either case, the data transferred between producer and consumer are the current calendar date and time divided in to a milliseconds part and a days part. These are transferred within one communication object with a 6 Byte on the CANopen network. The time stamp communication object is usually assigned to the COB-ID 256.

For details of specifying the date and time parameters see the descriptions of the packets mentioned below.



The Time Stamp Event is related to the following packets of the CANopen Slave protocol stack:

- `CANOPEN_SLAVE_SEND_TIME_STAMP_REQ/CNF` – Send Time Stamp allows your application to send a time stamp according to the CANopen time stamp protocol. In this case, the CANopen Slave acts as a producer. A time stamp event is caused at the side of the consumer(s) (recipient(s) of the time stamp message.
- `CANOPEN_SLAVE_RECV_TIME_STAMP_IND/RES` – Receive Time Stamp Indication for making your application aware of the reception of a time stamp sent by the Time Stamp Producer via the Time Stamp Protocol . In this case, the CANopen Slave acts as a consumer. Here, the time stamp event occurs at the CANopen Slave and needs to be handle there by your application.

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4.4.4.3 NMT Error Control Events

One of the tasks of Network Management (NMT) is the detection of failures within the CANopen network such as absent stations no more regularly transmitting PDOs. For this purpose, NMT provides the three NMT Error Control Events offering different error control services based on the periodic transmission of messages.

The CANopen Slave protocol stack supports the following kinds of NMT Error Control Events:

- Node Guarding / Life Guarding
- Heartbeat

It is mandatory to support one of these services. (However, a supported service may be deactivated at rub-time.)

The NMT Error Control Events are related to the following packet of the CANopen Slave protocol stack:

- `CANOPEN_SLAVE_ERR_CTRL_EVENT_IND/RES` – Error Control Event Indication for making your application aware of changes of the error control state within the entire CANopen network.

Node Guarding

The concept of node guarding consists mainly of the NMT Master maintaining a database containing the expected states of all connected NMT Slave devices (besides other information) and comparing these with their actual states which are regularly requested from the NMT Slave devices.

The Node Guarding Protocol works as follows:

The NMT Master cyclically polls in order to check whether the NMT Slave is still present at the bus. This polling is denominated as the guarding request. Actually, this is accomplished by sending a CAN remote frame to the NMT Slave.

The NMT Slave reacts by sending a CAN Data Frame with 1 Byte data. The most significant bit is toggled every time, i.e. it is 0 when it was 1 last time and vice versa. Bits 0 to 6 are used to transmit the state to the NMT State.

This is illustrated in *Figure 9: Node Guarding Protocol*.

The time between two guarding requests of the Master is denominated as the guard time.

Node Guarding can take place during the following states of the slave:

- *Pre-operational*
- *Operational*
- *Stopped*

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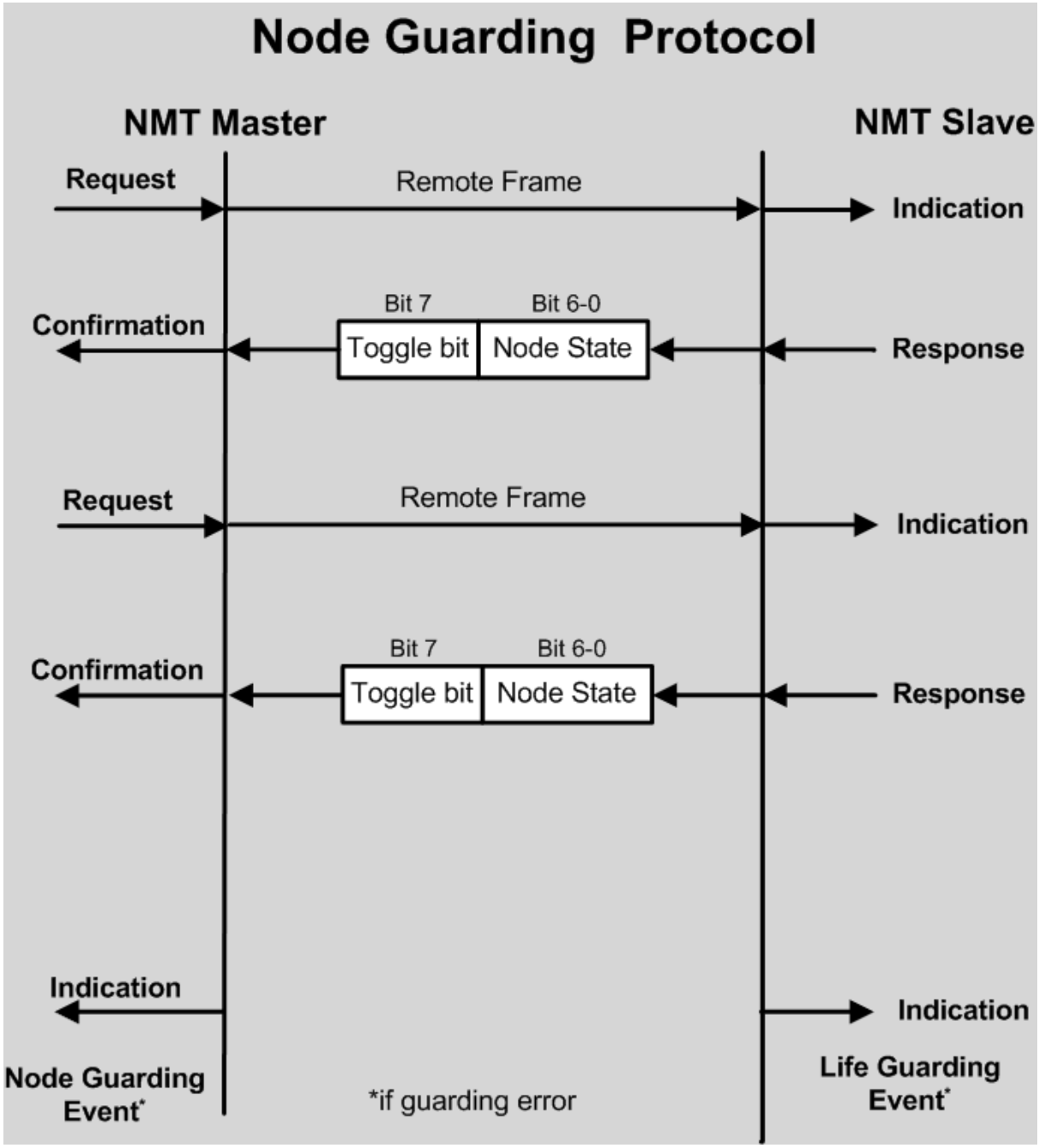

Figure 9: Node Guarding Protocol

Life Guarding

Additionally, the slaves try to detect possible failure of the Master. If they do not receive guarding requests within an (adjustable) time, they recognize this as failure of the Master (life-guarding event). This time is denominated as life time of the CANopen node. It must be longer than the guard time. The life time is usually specified as life-time factor which is then multiplied with the guard time in order to determine the life-time of the NMT Slave.

The guard time can be specified in object 0x100C of the object dictionary. The life time factor can be adjusted in object 0x100D. Both values set to 0 indicates the guarding feature is currently disabled. (In this case, it would be mandatory to use the Heartbeat feature described subsequently.

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Heartbeat

Alternatively, there is another error control service available which avoids sending remote frames: the Heartbeat Mechanism.

In the CANopen network, there may be one Heartbeat Producer cyclically sending heartbeat requests. The time between to such Heartbeat requests is denominated as the *Heartbeat Producer Time*.

There may be multiple Heartbeat Consumers within the CANopen network on which the Heartbeat signal is received and causes an indication. The Heartbeat Consumer supervises these indications. If in an (adjustable) time no such indication occurs, the Heartbeat Consumer assumes the Heartbeat Producer has failed and indicates a Heartbeat event. This time is denominated as Heartbeat Consumer Time. It is specified in multiples of 1 ms in object 0x1016 of the object dictionary.

The Producer Heartbeat Time set to 0 indicates the Heartbeat feature is currently disabled. (In this case, it would be mandatory to use the Node Guarding feature described above.

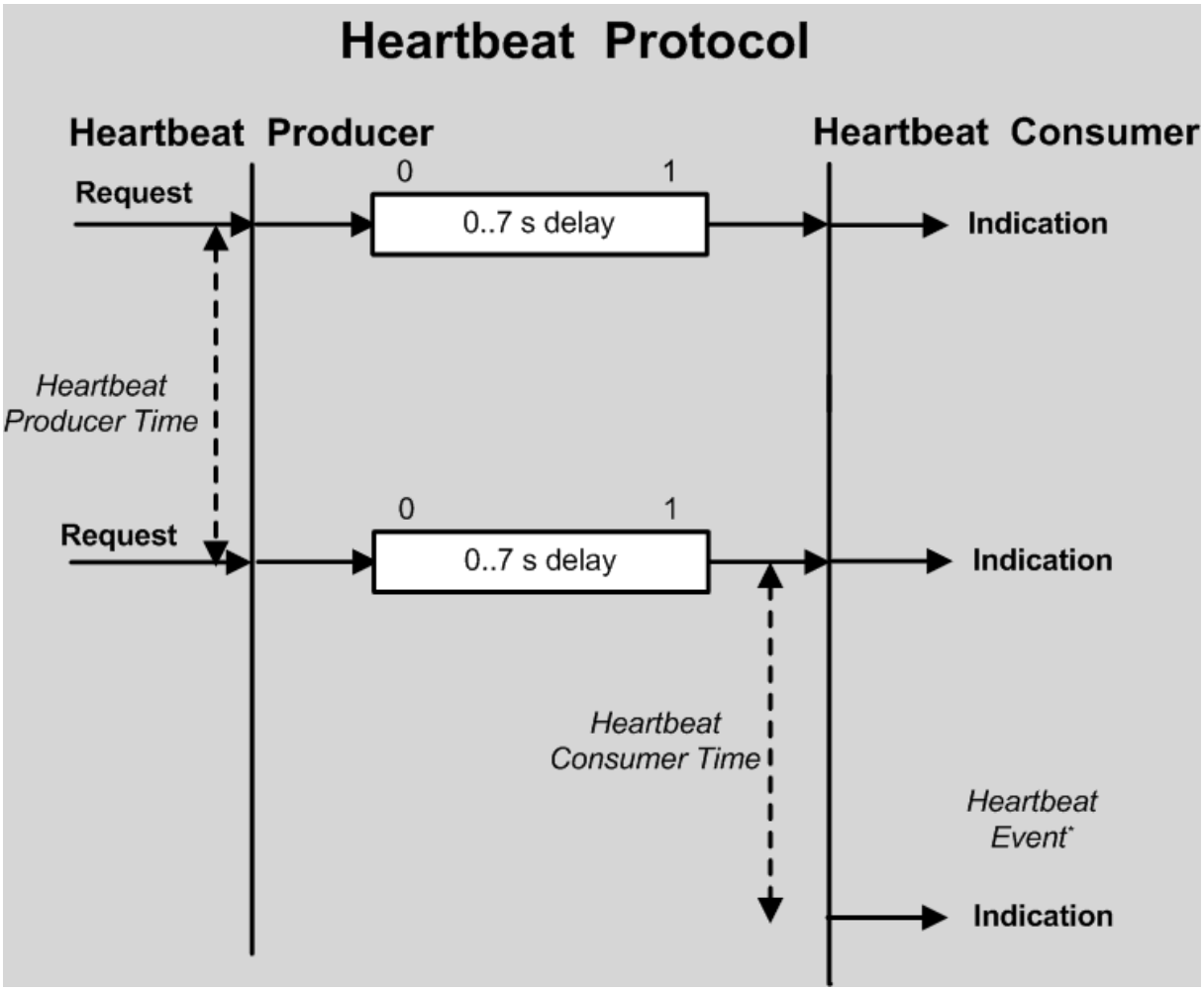

Figure 10: Heartbeat Protocol

Each CANopen device must implement Node Guarding/life-guarding or the heartbeat mechanism or both. If both are implemented, they may not both be active at the same time. It is recommended to use the heartbeat mechanism.

The `CANOPEN_SLAVE_ERR_CTRL_EVENT_IND/RES` – Error Control Event Indication informs you whenever anode guarding or heartbeat error occurs on the CANopen network or a CANopen Slave on the network starts or stops supervision by node guarding/life guarding or by heartbeat.

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4.4.4.4 Receive PDO Events

The PDO service allows to send application objects synchronously or asynchronously from one node (CANopen Master or Slave) to another one. In terms of the Producer-Consumer-Model, a CANopen Slave can act within a push model as a producer, and within a pull model both as a producer and as a consumer

The Receive PDO Event is related to the following packets of the CANopen Slave protocol stack:

- `CANOPEN_SLAVE_SEND_TXPDO_REQ` – Send TxPDO Request for sending a TxPDO to one or more communication partner(s) on the CANopen network and causing a Receive PDO Event there.
- `CANOPEN_SLAVE_RECV_RXPDO_REQ/CNF` – Receive RxPDO Request for sending an RTR frame in order to request an RxPDO from a communication partner on the CANopen network.
- `CANOPEN_SLAVE_RECV_RXPDO_IND/RES` – Receive RxPDO Indication for informing your application about the reception of a PDO (coming from another communication partner on the CANopen network).

The protocols of the 3 packets are illustrated at their packet descriptions.

As parameters, the requests contain an array of up to 16 affected PDO numbers. The confirmation packet contain a status code indicating whether or not the processing of the PDO has been successful. In case of failure you can evaluate this status code as error code for determining the cause of the error.

For details of PDOs, see section “*Process Data Objects (PDO)”* on page 61.

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4.4.4.5 NMT Command Events

NMT Command Events are used to inform the CANopen Slaves that the NMT Master requests a change of the Slave's NMT state.

The NMT Command Event service allows to NMT State change requests from the CANopen Master to one or more CANopen Slaves using the NMT Protocol. In terms of the Producer-Consumer-Model, a CANopen Slave acts within a push model as a consumer. The CANopen Master acts as producer.

When receiving an NMT command request, the application should react in the following manner:

1. Determine which service needs to be executed
2. Execute requested service
3. Send response packet.

For determining which service should be executed, the value of variable `ulNmtCommand` must be evaluated according to the following table:

Value	Requested Service	Action to take
1	Start CANopen Slave	Set state to *Operational*
2	Stop CANopen Slave	Set state to *Stopped*
128	Enter state *Pre-operational*	Set state to *Pre-operational*
129	*Reset node*	Set state to *Initialising*, sub-state *Reset node*
130	*Reset communication*	Set state to *Initialising*, sub-state *Reset communication*

Table 32: NMT States

If the application has been previously registered for this event, the automatic switching to the new state will be inhibited. For switching to the new local NMT state, the application is responsible exclusively. You can then use the new local NMT state of the CANopen Slave after service execution as value for parameter `ulNmtState` in the response packet.

If the application has not been registered for this event previously, switching to the new state will be done automatically.

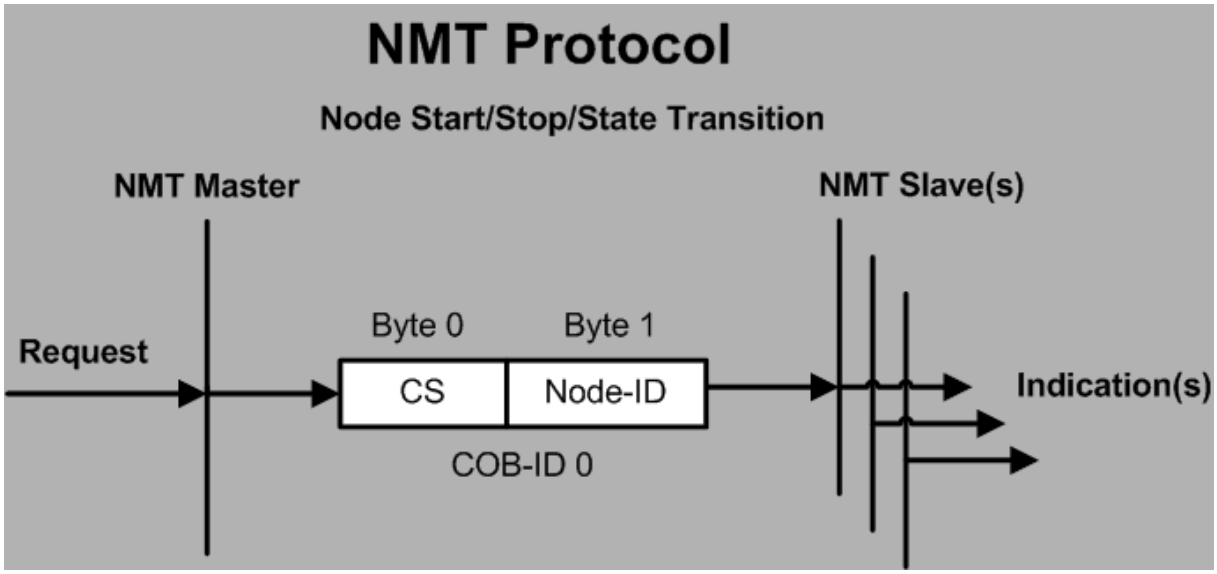

Figure 11: Node Start/Stop State Transition

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The parameters are transferred within one communication object with 2 Byte on the CANopen network. The NMT communication object is always assigned to the COB-ID 0 which is the COB-ID with the highest priority at all.

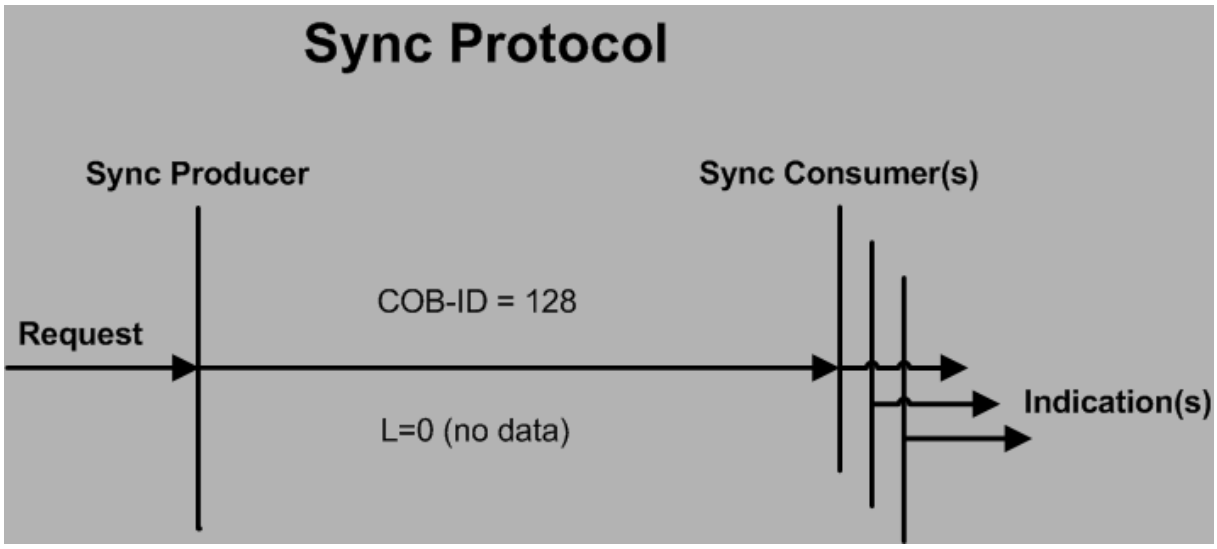
The NMT Command Events are related to the following packets of the CANopen Slave protocol stack:

- `CANOPEN_SLAVE_NMT_COMMAND_IND/RES` – NMT Command Indication for making your application aware of external requests for a state change in the NMT Slave State Machine. The NMT Command Event occurs at the CANopen Slave.
- `CANOPEN_SLAVE_NMT_STATE_CHANGE_IND/RES` – NMT State Change Indication indicating a change of the state within the CANopen Slave's NMT State Machine and allowing the application to react and perform all necessary application-internal changes required after the change of NMT state.

4.4.4.6 Synchronization Event (SYNC)

The Synchronization Event is used to synchronize PDO processing with a highly precise time signal.

This allows performing synchronous PDOs (Cyclic and acyclic). For details on synchronous PDOs, see section "*Process Data Objects (PDO)"* on page 61. The part of the CANopen Slave device that provides the SYNC signal is denominated as the SYNC Producer. SYNC Consumers are all parts of the Slave which perform synchronized data processing.



The Synchronization Event does not transfer any data, therefore the signal is transferred within one communication object with a data length of 0 Byte (or 1 Byte) on the CANopen network.

The recommended COB-ID for the NMT communication object is 128. This is the same value as used in the predefined connection set.

The object dictionary contains three relevant values concerning the SYNC event.

- The actual value of the COB-ID of the SYNC object can be retrieved from object 0x1005 within the object dictionary.
- Object 0x1006 contains the communication cycle time. This value represents the time between two subsequent SYNC events (this object is not supported by the CANopen Slave V3 protocol stack).
- Object 0x1007 contains the synchronous window length. The synchronous window length specifies the time within which the synchronous PDOs may be processed. Its value must be

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smaller than the applied communication cycle time. (this object is not supported by the CANopen Slave V3 protocol stack)

The SYNC Event is related to the working with synchronous PDOs, see section 4.4.5.4“*Synchronous vs. asynchronous Data Transmission*” on page 64.

4.4.4.7 Emergency Event (EMCY)

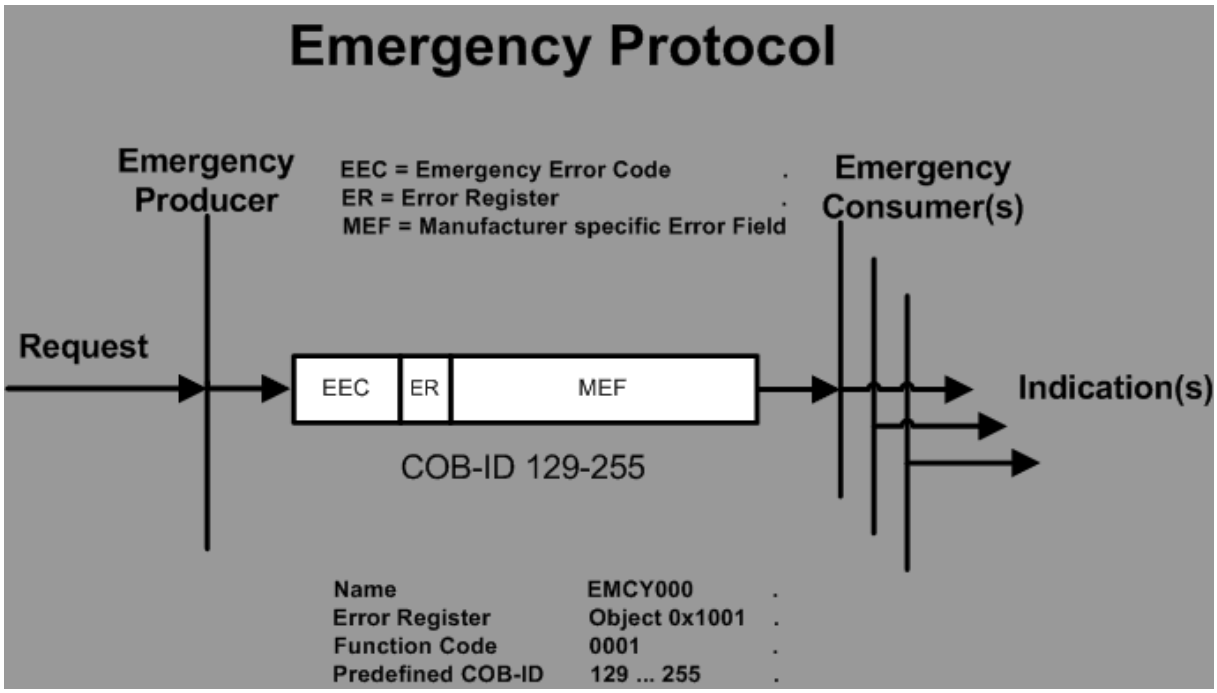

Table 33: Emergency Protocol

The parameters are transferred within one communication object on the CANopen network. The NMT communication object is usually assigned to a COB-ID in the range between 129 and 255.It delivers

- An emergency error code
- An error register
- 5 bytes of manufacturer-specific error information

The Emergency Event (EMCY) is related to the following packets of the CANopen Slave protocol stack:

- `CANOPEN_SLAVE_SEND_EMCY_REQ/CNF` – Send Emergency Message allowing you to send an emergency telegram from your application to any consumer within the CANopen network.

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4.4.5 Process Data Objects (PDO)

Process Data Objects (short: PDO) provide the fastest way for data transmission in CANopen. One single PDO can be considered as a segment of the whole process data with a length of 8 Bytes. On low level (CAN-DL), each PDO is transmitted as a single CAN telegram, and the length of CAN telegrams is limited to 8 Bytes. Due to this fact there is an 8 byte limit of the PDO length.

One of the most important advantages of the PDO concept is that PDOs are transmitted without any protocol overhead. This allows good performance.

4.4.5.1 Producer-Consumer Model

PDO communication follows the Producer-Consumer Model:

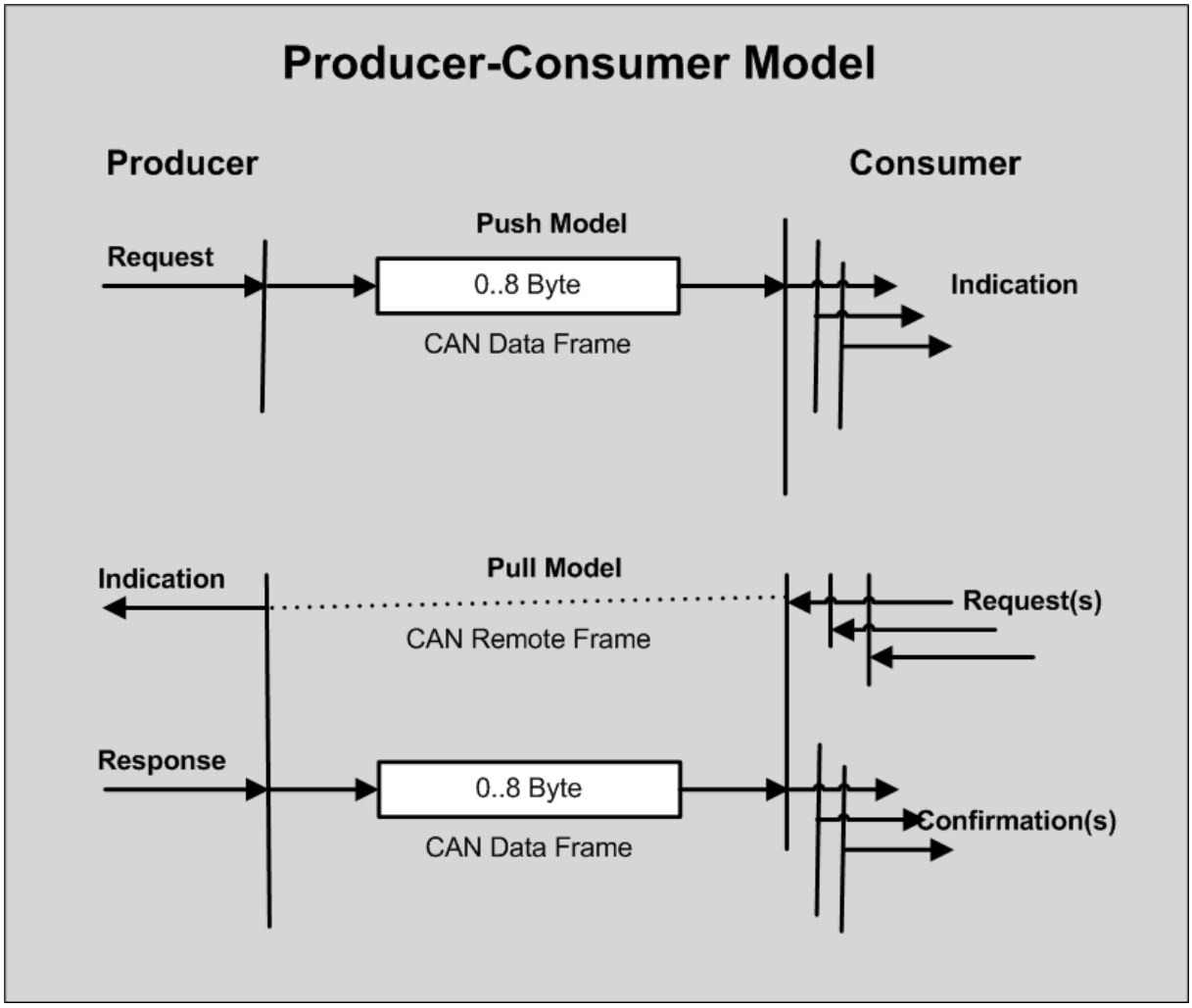

Figure 12: Producer-Consumer Model

In the Producer-Consumer Model, each node may send data at any time (for instance in case of a pre-defined event happening). Each station may listen to the transmitted messages. When a message is received, the node decides on its own whether the message is accepted, or not.

This offers the advantage of greater flexibility and easy establishment of event-driven processing for instance compared to the Master-Slave Model..

Data transmission is done from a device (the *Producer*) to one or more other devices (the *Consumer(s)*) without any confirmation (non-confirmed mode).The broadcast mechanism of the CAN low-level protocol is used to accomplish this .The assignment is made via identifiers which must match between Producer and Consumer.

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4.4.5.2 Services

There are two services available for dealing with PDOs:

- The Write Service

  The Write Service is implemented by the packet `CANOPEN_SLAVE_SEND_TXPDO_REQ` – Send TxPDO Request. It acts on the Transmit-PDOs (TxPDOs).

- and the Read Service.

  The Read Service is implemented by the packets `CANOPEN_SLAVE_RECV_RXPDO_REQ/CNF` – Receive RxPDO Request and `CANOPEN_SLAVE_RECV_RXPDO_IND/RES` – Receive RxPDO Indication. It acts on the Receive-PDOs (RxPDOs).

Important note: The perspective of view to be applied in this context is that of the CANopen device. An IO device acting as CANopen Slave would send its input data via its TxPDOs and receive its output data via its RxPDOs.

The CANopen Slave protocol stack limits the number of available TxPDOs and RxPDOs to 8 each (for Hilscher devices with the netX 10 processor) and to 64 each (for any other netX-based Hilscher devices).

The numbers and the length of the PDOs are application-specific and must be defined in the device's profile.

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4.4.5.3 Modes of Communication

A PDO can be scheduled in three different ways. It can be driven:

- By an internal event or an event timer
- By a remote request
- Synchronously (cyclic or acyclic)

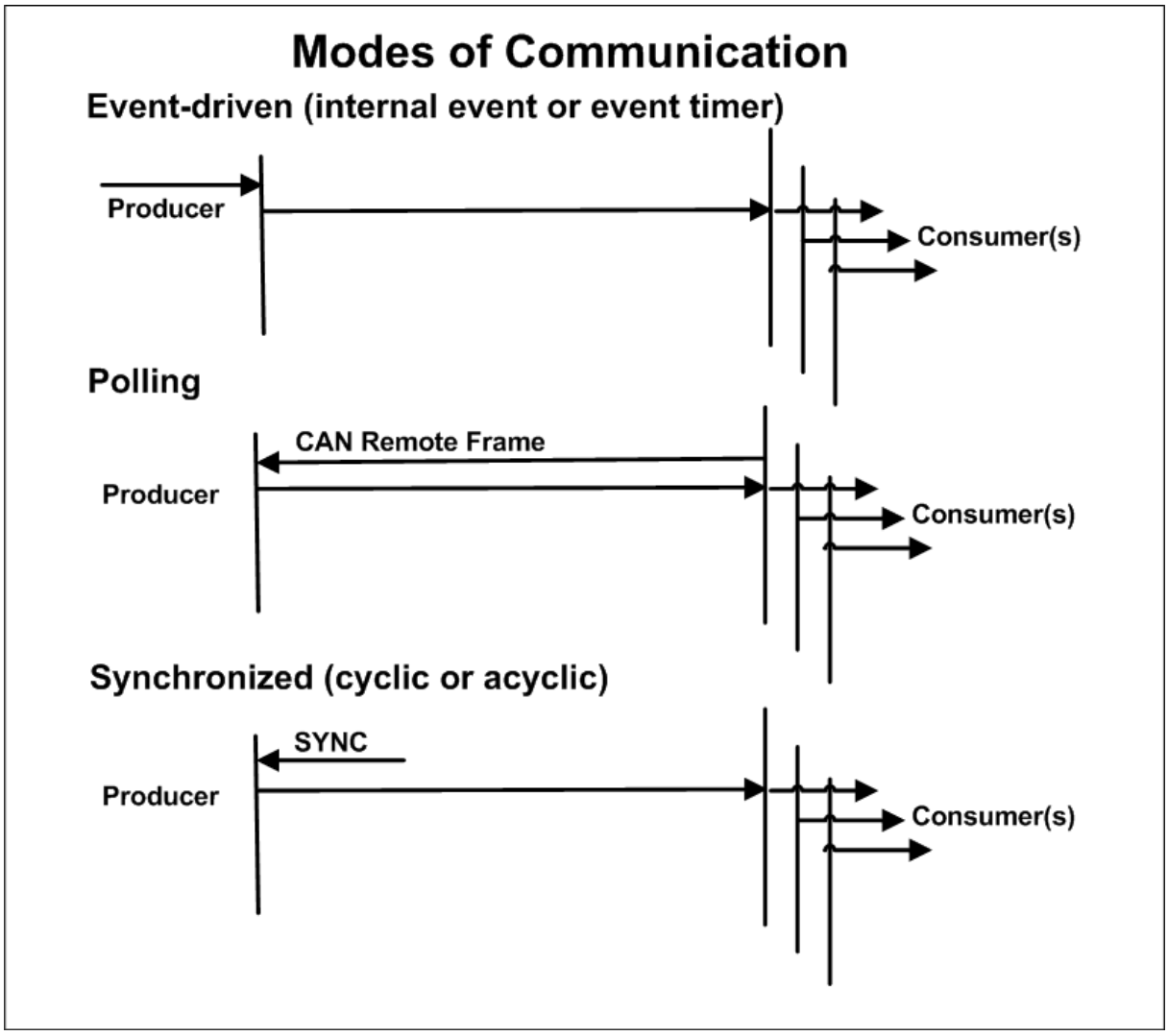

Figure 13: Modes of Communication: Event-driven, Polling, Synchronized

Event-driven communication

A PDO can be transmitted when a specific event that has been previously defined occurs locally at the producer This communication mode is called event-driven PDO communication. The driving event may be any local event such as a change of an input or elapsing of a specific timer.

This case is equivalent to the push model described above.

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Polling by CAN remote frames

A consumer can also stimulate the PDO transmission. This case is equivalent to the pull model described above. This is internally accomplished by sending a RTR Frame to the producer. The producer will then automatically "answer" by transmission of the PDO in a CAN Data Frame.

Synchronized communication

Transmission of a PDO can be triggered periodically (i.e. a repeated and precise time synchronization signal is received). For this purpose, CANopen provides the SYNC object..

The PDO can be coupled to the SYNC object. This forces the CANopen Slave to process the PDOs (TxPDOs and RxPDOs).

Let us now clarify the terms *synchronous*, *asynchronous*, *cyclic* and *acyclic* in context with data transmission

4.4.5.4 Synchronous vs. asynchronous Data Transmission

CAN distinguishes between synchronous and asynchronous data transmission.

- Synchronous data transmission means in this context coupled to a synchronization signal (such as the one supplied by the SYNC object). Synchronous data transmission takes place within a well-defined time window following the SYNC signal. PDOs offer the only mechanism for synchronous data transmission. It is strongly recommended that the priority of synchronous PDOs should be higher than that of the asynchronous PDOs.
- Asynchronous data transmission means in this context event-driven. Asynchronous data transmission can generally take place at any time without restriction.

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4.4.5.5 Cyclic and acyclic Data Transmission

CAN also distinguishes between two forms of synchronous data transmission, namely cyclic data transmission and acyclic data transmission.

- Cyclic data transmission means periodic data transmission coupled to the SYNC signal. However, this does not necessary mean one transmission at every SYNC event. You can define the transmission type, i.e. a number of SYNC events to occur between to synchronous data transmissions. This number may be chosen from the range from 1 to 240. Thus transmission type 1 means one transmission at every SYNC event., transmission type 2 means one transmission at every second SYNC event and so on.
- Acyclic data transmission means data transmission triggered by an application-specific event. Message transmission occurs synchronized to the SYNC event but not periodically.

4.4.5.6 Transmission Types

There are also some other transmission types for special cases. The following table introduces the complete rules that apply for the transmission types

Type #	Cyclic	Acyclic	Synch.	Asynch.	RTR only
0		x	x		
1…240[1]	x		x		
241…251			reserved		
252			x		x
253				x	x
254[2]				x	
255[3]				x	

Table 34: PDO Transmission Types

1) This value specifies exactly the number of SNC events between two transmissions of the PDO.

2) Device-specific application event

3) Device-profile defines application event

Transmission types 254 and 255 differ in the following aspect:

- Transmission type 254 is used for device-specific application events.
- Transmission type 255 is used for application events defined in the device profile.

4.4.5.7 Inhibit Time and Event Timer

Additionally, there are two important features that can be assigned only to TxPDOs, namely as the

- the Inhibit Time
- and the Event Timer.

The Inhibit Time is defined as the minimum time required to elapse between two consecutive invocations of the service of a PDO. If this time is set to a value significantly larger than the time need to process the synchronous PDO, this feature gives acyclic or asynchronous PDOs with lower priority than the synchronous PDO better chances to be processed quickly. Values are specified in units of 100 µs. As long as the PDO exists (this is indicated by bit 31 of subindex 1 of the PDO's index being 0), this value must not be changed any more!

The Event Timer

For asynchronous TxPDOs (i.e. such event-driven TxPDOs with transmission types 254 and 255), additionally an Event Timer can be set. Values are specified in units of 1 ms. If the specified time has elapsed, this will be considered as an event and will therefore cause the PDO to be transmitted.

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The Inhibit Time may specify the earliest time transmission can take place and, similarly, the Event Timer may specify the latest time transmission can take place. This allows to set up a “virtual transmission window” for the timely execution of the TxPDO’s transmission in case of asynchronous . (This feature can be used for reducing bus-load).

4.4.5.8 Communication Parameters

In the object dictionary, there is a PDO communication parameter assigned to each PDO. It describes the communication behaviour of the PDO.

The communication parameter can be found at:

- `0x1400-0x15FF` (`0x1400` for the first RxPDO)
- `0x1800-0x19FF` (`0x1800` for the first TxPDO

The next PDO has an index which is increased by one and so forth.

The communication parameter has the following content:

Index #	Subindex	Description	Data Type
0x1400-… 0x15FF (RxPDO) or 0x1800 … 0x19FF (TxPDO)	0x00	Number of entries	Unsigned8
	0x01	CANopen identifier (COB-ID)	Unsigned32
	0x02	Transmission Type	Unsigned8
	0x03	Inhibit Time	Unsigned16
	0x04	Reserved	Unsigned8
	0x05	Event Timer	Unsigned16

Table 35: PDO Communication Parameter

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4.4.5.9 PDO Mapping

The PDOs provide the interface to the application objects. They are assigned to the entries in the object dictionary. The process of assignment is denominated as PDO mapping and is practically accomplished via a specific mapping structure in the object dictionary.

This mapping structure can be found at:

- `0x1600-0x17FF` (0x1600 for the first RxPDO)
- `0x1A00-0x1BFF` (0x1A00 for the first TxPDO

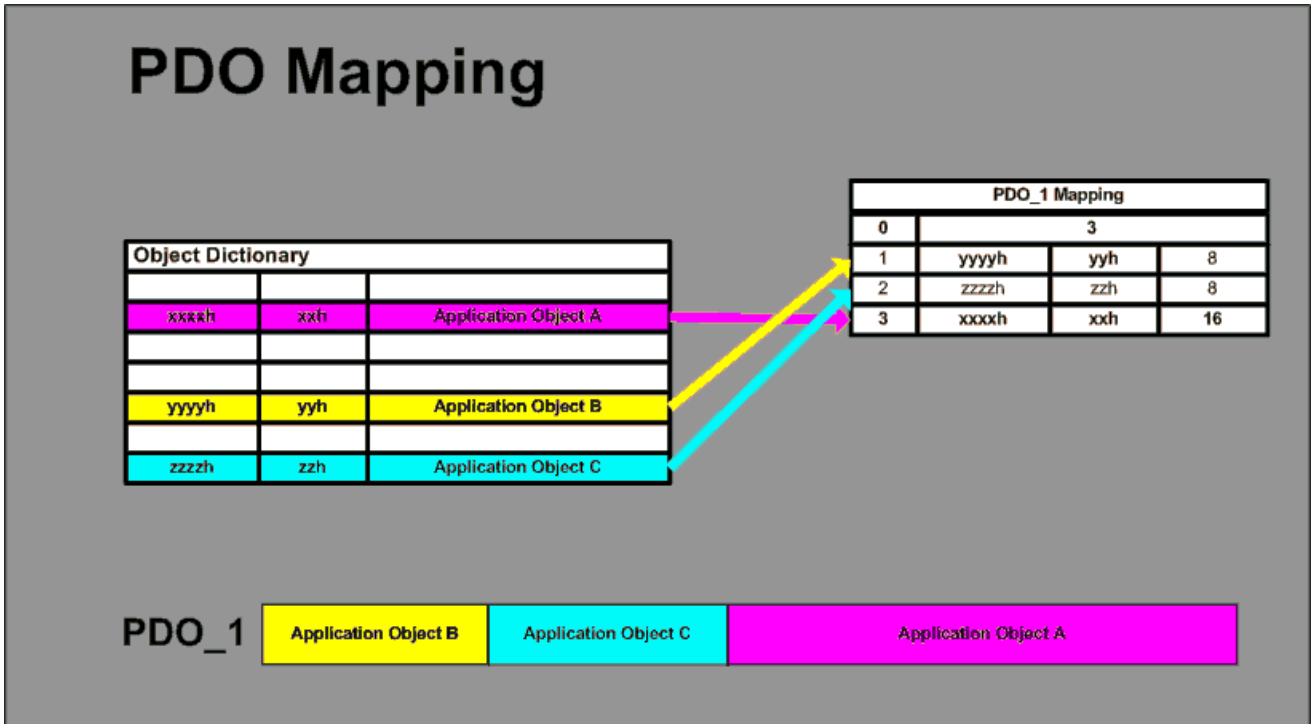

Figure 14: PDO Mapping

Figure 14: PDO Mapping explains the relationship between object dictionary (left upper part), PDO mapping structure (right upper part) and the resulting PDO containing the application objects to be mapped (lower part).

One entry in the PDO mapping table requires 32 bit. It consists of:

- 16 bit containing the index of the object dictionary entry containing the application object to be mapped
- 8 bit containing the subindex of the object dictionary entry containing the application object to be mapped
- 8 bit containing the length information.

The PDO mapping table can at maximum contain 8 of such entries, therefore the number of application objects in one PDO is also limited to 8.

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4.5 Standard Mode vs. Extended Mode

The CANopen Slave V3 Protocol Stack can be configured in two different modes:

- *Standard Mode* (Object-based DPM content)
- *Extended Mode* (PDO based DPM content)

4.5.1 How to decide between Operation in Standard Mode and Extended Mode

The choice of the mode has a large influence on the behavior, the internal operation and the configuration facilities of the stack. The choice which one of these to use should be made according to the following rules:

Standard Mode

1. If your intention is to run existing applications from CANopen Slave Stack V2, you should definitely decide to use *Standard Mode*. Running existing applications with only slight changes is possible as *Standard Mode* offers a high degree of compatibility to the CANopen Slave Stack V2.
2. Also, if you want to avoid having to fill in larger amounts of objects into the object dictionary, it is recommended to use the *Standard Mode*.

Extended Mode

On the other hand, it is recommended to use the *Extended Mode* if you want to implement a complete device profile, if you want to work with an object dictionary of your own, if you want to map objects which had been added to the object dictionary by your application or if you do not have any legacy applications. Only *Extended Mode* allows to fully exploit the new possibilities of the CANopen Slave V3 Protocol Stack.

4.5.2 Where can I switch between Standard Mode and Extended Mode?

If the Extended Mode Flag (= BIT29 of the CANopen flags in `CANOPEN_SLAVE_BUSPARAM_DATA_T`) is set to TRUE (i.e. set to 1), then the CANopen Slave V3 Protocol Stack is in *Extended Mode*. If this flag is set to FALSE (i.e. set to zero), then the CANopen Slave V3 Protocol Stack is in *Standard Mode*. For more information, see *Table 45: Bus parameter structure CANOPEN_SLAVE_BUSPARAM_DATA_T*.

Let us now explain in detail the most important differences between *Standard Mode* and *Extended Mode*.

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4.5.3 Standard Mode

The *Standard Mode* is characterized by the following features:

- The *Standard Mode* has been designed for maximum compatibility to existing applications for CANopen Slave V2.
- The bus parameter structure CANOPEN_SLAVE_STD_BUSPARAM_DATA_T is applied, see *Table 45: Bus parameter structure CANOPEN_SLAVE_BUSPARAM_DATA_T* on page 78.
- Configuration can be done with tools (System configurator *SYCON.net* or *netX Configuration Tool*) or by *"Set Configuration"* packet.
- The DPM contains the content of the objects 0x2000 to 0x2003 (TxPDOs) and 0x2200 to 0x2203 (RxPDOs).
- The object dictionary is completely filled with objects up to the maximum extent supported at that time. According to the entries made in the EDS file, all entries are automatically created within the object dictionary. For a precise list of supported entries, see subsection 4.5.5 "*Object Dictionary with Firmware Functionality*" on page 72 below.
- If further objects are added later, these cannot be PDO-mapped in *Standard Mode*.

4.5.3.1 Configuring the Standard Mode

The standard bus parameter structure CANOPEN_SLAVE_STD_BUSPARAM_DATA_T is used. It consists of the following items:

Parameter	Type	Meaning	Range of Values/ Default
ulVendorId	UINT32	Vendor code if corresponding bit in parameter ulCanopenFlags is set	
ulProductCode	UINT32	Product code if corresponding bit in parameter ulCanopenFlags is set	
ulSerialNumber	UINT32	Serial number if corresponding bit in parameter ulCanopenFlags is set	
ulRevisionNumber	UINT32	Revision number if corresponding bit in parameter ulCanopenFlags is set	
ulDeviceType	UINT32	Device Type if corresponding bit in parameter ulCanopenFlags is set	
bObject2000Size	UINT8	Size of object 0x2000	
bObject2001Size	UINT8	Size of object 0x2001	
bObject2002Size	UINT8	Size of object 0x2002	
bObject2003Size	UINT8	Size of object 0x2003	
bObject2200Size	UINT8	Size of object 0x2200	
bObject2201Size	UINT8	Size of object 0x2201	
bObject2202Size	UINT8	Size of object 0x2202	
bObject2203Size	UINT8	Size of object 0x2203	
usNumOfRxPdo	UINT16	Number of Receive PDOs	0..256
usNumOfTxPdo	UINT16	Number of Transmit PDOs	0..256
aulReserved[2]	UINT32[2]	Reserved, set to zero	

Table 36: Standard bus parameter structure CANOPEN_SLAVE_STD_BUSPARAM_DATA_T

The ulVendorId parameter provides the value for the Vendor ID entry in the object dictionary of the CANopen slave (Object 0x1018, sub-index 1) if bit 4 in parameter ulCanopenFlags is set. Otherwise, the vendor ID is set to zero.

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The `ulProductCode` parameter provides the value for the product code entry in the object dictionary of the CANopen slave (Object 0x1018, sub-index 2) if bit 5 in parameter `ulCanopenFlags` is set. Otherwise, the product code is set to zero.

The `ulSerialNumber` parameter provides the value for the serial number entry in the object dictionary of the CANopen slave (Object 0x1018, sub-index 4) if bit 6 in parameter `ulCanopenFlags` is set. Otherwise, the serial number is set to zero.

The `ulRevisionNumber` parameter provides the value for the revision number entry in the object dictionary of the CANopen slave (Object 0x1018, sub-index 3) if bit 7 in parameter `ulCanopenFlags` is set. Otherwise, the revision number is set to default.

4.5.3.2 Handling of Process Data in Standard Mode

The CANopen slave implementation V3 provides 4 objects (0x2000…0x2003) for send data and 4 objects of receive data (0x2200…0x2203); each object has up to 256 bytes of process data (Standard: 128 bytes, minimum: 0 bytes) and is transferred via PDO according to the active network configuration.

The data of these buffers are exchanged between the AP-Task and the CANopen slave-Task. The AP-Task transfers data from the receive buffers to the DPM input image and from the DPM output image to the send buffers.

Mapping of Input and Output Image to Send and Receive Objects

The data of the send and receive objects are mapped linearly to the input and output image of the DPM as shown in the following table:

DPM input image byte offset	Receive object index	Receive object sub-index
0	2200h	01h
1	2200h	02h
..	..	..
127	2200h	80h
128	2201h	01h
..	..	..
510	2203h	7Fh
511	2203h	80h

Table 37: Mapping of Input Data (in case of unchanged object lengths and no netX 10 applied)

DPM output image byte offset	Send object index	Send object sub-index
0	2000h	01h
1	2000h	02h
..	..	..
127	2000h	80h
128	2001h	01h
..	..	..
510	2003h	7Fh
511	2003h	80h

Table 38: Mapping of Output Data (in case of unchanged object lengths and no netX 10 applied)

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4.5.4 Extended Mode

The *Extended Mode* is characterized by the following features:

- The *Extended Mode* has been designed for maximum flexibility, for instance, if you want to create an object directory of your own or you want to create your own device profile.
- The extended bus parameter structure CANOPEN_SLAVE_EXT_BUSPARAM_DATA_T is applied, see *Table 39: Extended bus parameter structure CANOPEN_SLAVE_EXT_BUSPARAM_DATA_T* on page 71.
- The AUTOSTART option is not available.
- Configuration can only be done by *"Set Configuration"* packet. Currently, there are no suitable configuration tools available.
- The DPM contains the PDOs (DPM Byte 0…7: PDO1, DPM Byte 8…15: PDO2, and so on.).
- The object dictionary must completely be set up manually. For each of the entries made in the EDS file that you want to use, the according entries must be made in the object dictionary (via ODV3/object create and write). For a precise list of entries that can be set up, see subsection 4.5.5 "*Object Dictionary with Firmware Functionality*" on page 72 below.
- If further objects are added later, these may be mapped in *Extended Mode*.

4.5.4.1 Configuring the Extended Mode

The extended bus parameter structure CANOPEN_SLAVE_EXT_BUSPARAM_DATA_T is used.

It consists of the following items:

Parameter	Type	Meaning	Range of Values
usNumOfRxPdo	UINT16	Number of Receive PDOs	0.. 256
usNumOfTxPdo	UINT16	Number of Transmit PDOs	0.. 256
aulReserved[9]	UINT32[9]	Reserved, set to zero	

Table 39: Extended bus parameter structure CANOPEN_SLAVE_EXT_BUSPARAM_DATA_T

4.5.4.2 Handling of Process Data in Extended Mode

The 4 objects (0x2000…0x2003) for send data and 4 objects of receive data (0x2200…0x2203) are not used in *Extended Mode*. In the *Extended Mode*, the DPM contains PDOs instead of objects.

4.5.4.3 Start Sequence of Extended Mode

The following sequence of steps is necessary to get the *Extended Mode* running after the bus parameters have been set:

1. Create all necessary objects within the object dictionary. Only objects mentioned in Table 40: Supported Object Dictionary Entries (Communication Profile, present in the EDS file) below make sense in this context.
2. Register all required indications (however, a later registration is also possible).
3. Start communication. This causes a verification whether sufficient information is available to start up the protocol stack. For example, if 3 PDOs are configured, the objects 0x1400, 0x1600, 0x1401, 0x1601, 0x1402 and 0x1602 must exist and will be checked for existence.
4. Then, no communication objects may be deleted anymore.

Note: In *Extended Mode*, configuration can only be done by *"Set Configuration"* packet. However, the auto-start option is not available.

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4.5.5 Object Dictionary with Firmware Functionality

The following contains a list of object dictionary entries with Firmware Functionality. These should be exactly the ones mentioned within the EDS file. Only these object dictionary entries can be managed by the CANopen Slave V3 Protocol Stack.

However, this is done in a quite different manner in *Standard Mode* and in *Extended Mode.*

- In *Standard Mode;* all these entries are created by the CANopen Slave by default and are available. They may not be deleted.
- In *Extended Mode,* these entries will be supported by the firmware if you create them manually using the ODV3 capabilities (object create/write). It does not make sense to create other entries of the communication profile unless you completely implement the functionality of such an entry on your own.

Now, this is the list of object dictionary entries with firmware functionality:

Index of Object	Name of Object	Comment
0x1000	Device type	This object is mandatory
0x1001	Error register	This object is mandatory
0x1005	COB-ID SYNC	Consumer only
0x100C	Guard Time	
0x100D	Life Time Factor	
0x1012	COB-ID Time Stamp	Producer and consumer
0x1014	COB-ID EMCY	Producer
0x1015	Inhibit time Emergency	
0x1016	Heartbeat Consumer Entries	Contains up to 64 entries
0x1017	Producer Heartbeat Time	
0x1018	Identity Object	This object is mandatory
0x1029	Error Behavior	The following error behaviors have between implemented in the CANopen Slave V3 protocol stack: - *Remain* (no change of NMT state) - *Stopped* - *Pre-operational* (if operational)
0x1200	Server SDO Parameter 1	
0x1400…143F	RxPDO Communication Parameters	Up to 8 mappable objects per PDO
0x1600…163F	RxPDO Mapping	Up to 8 mappable objects per PDO
0x1800…183F	TxPDO Communication Parameters	Up to 8 mappable objects per PDO
0x1A00.. 1A3F	TxPDO Mapping	Up to 8 mappable objects per PDO

Table 40: Supported Object Dictionary Entries (Communication Profile, present in the EDS file)

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Additionally, only for the *Standard Mode*, the following objects of the manufacturer-specific profile are available:

Index of Object	Name of Object	Default (not for netX 10)	Minimum	Maximum
0x2000	Bytes in (1)	128 Bytes	0 Bytes	256 Bytes
0x2001	Bytes in (2)	128 Bytes	0 Bytes	256Bytes
0x2002	Bytes in (3)	128 Bytes	0 Bytes	256Bytes
0x2003	Bytes in (4)	128 Bytes	0 Bytes	256Bytes
0x2200	Bytes out (1)	128 Bytes	0 Bytes	256Bytes
0x2201	Bytes out (2)	128 Bytes	0 Bytes	256Bytes
0x2202	Bytes out (3)	128 Bytes	0 Bytes	256Bytes
0x2203	Bytes out (4)	128 Bytes	0 Bytes	256Bytes

Table 41: Supported Object Dictionary Entries (Manufacturer-specific Profile, present in the EDS file)

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5 The Application Interface

This chapter defines the application user interface of the CANopen slave stack.

The application itself has to be developed as a Task according to the Hilscher's Task Layer Reference Model. The Application-Task is named AP-Task in the following sections and chapters.

The AP-Task's process queue is keeping track of all its incoming packets and has to be addressed from the user application. It provides the communication channel for the underlying CANopen slave stack. Once, the CANopen slave stack communication is established, events received by the stack are mapped to packets that are sent to the AP-Task's process queue. On one hand every packet has to be evaluated in the AP-Task's context and corresponding actions be executed. On the other hand, Initiator-Services that are be requested by the AP-Task itself are sent via predefined queue macros to the underlying CANopen slave stack queues via packets as well. The AP-Task will not route all commands to the CANopen slave task. Some commands are used for internal communication between the AP- and CANopen slave-Task only. Other requests are not possible in specific states.

5.1 The CANopen-APS-Task

To get the handle of the process queue of the CANopen-APS-task the Macro `TLR_QUE_IDENTIFY()` needs to be used.

ASCII queue name	Description
"QUE_CANOPENAPS"	Name of the APS-Task process queue

Table 42: APM-Task Process Queue

The returned handle has to be used as value `ulDest` in all request packets to be sent to the AP-Task. This handle is the same handle that has to be used in conjunction with the macros like `TLR_QUE_SENDPACKET_FIFO/LIFO()` for sending a packet to the AP-Task.

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5.1.1 CANOPEN_APS_GET_STATE_REQ/CNF – Get State of AP-Task

This request can be used by the user application to get status information from the AP-Task.

Packet Structure Reference

```
typedef struct CANOPEN_APS_PCK_GET_STATE_REQ_Ttag
  CANOPEN_APS_PCK_GET_STATE_REQ_T;

struct CANOPEN_APS_PCK_GET_STATE_REQ_Ttag   /* Get state request */
{
  TLR_PACKET_HEADER_T tHead;  /** packet header */
};
```

Packet Description

Structure Information CANOPEN_APS_PCK_GET_STATE_REQ_T				Type: Request
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	Structure TLR_PACKET_HEADER_T			
	ulDest	UINT32	0x20/ QUE_CANOPEN APS	Destination Queue-Handle of CANopen slave-Task Process Queue
	ulSrc	UINT32	0 ... 2^{32}-1	Source Queue-Handle of AP-Task Process Queue
	ulDestId	UINT32	ulCANOPENSL V0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process
	ulSrcId	UINT32	ulAPSS0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	0	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32		*See section 6.1.1 Codes of the CANopen-APS-Task*
	ulCmd	UINT32	0x2E02	CANOPEN_APS_GET_STATE_REQ - Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch

Table 43: CANOPEN_APS_PCK_GET_STATE_REQ_T – Get State of AP-Task Request

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Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_APS_GET_STATE_CNF_DATA_Ttag</code> */
typedef struct CANOPEN_APS_GET_STATE_CNF_DATA_Ttag
  CANOPEN_APS_GET_STATE_CNF_DATA_T;

struct CANOPEN_APS_GET_STATE_CNF_DATA_Ttag
{
  TLR_UINT32 aulUnused[2];
};

/*****************************************************************************/
/** type of <code>CANOPEN_APS_PCK_GET_STATE_CNF_Ttag</code> */
typedef struct CANOPEN_APS_PCK_GET_STATE_CNF_Ttag
  CANOPEN_APS_PCK_GET_STATE_CNF_T;

struct CANOPEN_APS_PCK_GET_STATE_CNF_Ttag /* Get state confirmation */
{
  TLR_PACKET_HEADER_T               tHead;   /** packet header */
  CANOPEN_APS_GET_STATE_CNF_DATA_T  tData;   /** packet data   */

};

/*****************************************************************************/
```

Packet Description

Structure Information CANOPEN_APS_PCK_GET_STATE_CNF_T				Type: Confirmation
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	Structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle, untouched
	ulSrc	UINT32		Source Queue-Handle, untouched
	ulDestId	UINT32	ulAPSS0Id	Destination End Point Identifier, untouched
	ulSrcId	UINT32	ulCANOPENSLV0Id	Source End Point Identifier, untouched
	ulLen	UINT32	8	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32		*See section 6.1.1 Codes of the CANopen-APS-Task*
	ulCmd	UINT32	0x00002E03	CANOPEN_APS_GET_STATE_CNF - Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch
tData	Structure CANOPEN_APS_GET_STATE_CNF_DATA_T			
	aulUnused[]	UINT32 [2]		Unused, present only due to compatibility reasons

Table 44: CANOPEN_APS_PCK_GET_STATE_CNF_T – Get State of AP-Task Confirmation

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5.1.2 CANOPEN_APS_SET_CONFIGURATION_REQ/CNF – Set Configuration

This service can be used by the user application in order to configure the AP-task with configuration parameters(formerly called warmstart parameters). After this request is received, the AP-task will configure the CANopen Slave V3 task with the given parameters from this request and, if configured, starts the communication with the CANopen network.

The following applies:

- Configuration parameters will be stored internally.
- In case of any error no data will be stored at all.
- A channel init is required to activate the parameterized data.
- This packet does not perform any registration at the stack automatically. Registering must be performed with a separate packet such as the registration packet described in the netX Dual-Port-Memory Manual (`RCX_REGISTER_APP_REQ`, code `0x2F10`).
- This request will be denied if the configuration lock flag is set
  (for more information on this topic see section 3.3.1 “*Common Status*”).

The bus parameter structure `CANOPEN_SLAVE_BUSPARAM_DATA_T` related to parameter `tDeviceCfg` consists of the following items:

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Parameter	Type	Meaning	Range of Values
ulSlaveNodeId	UINT32	Node ID of CANopen Slave	1..127
ulBaudrate	UINT32	Baudrate for CANopen network	Allowed values: see *Table 46: Codes and Corresponding Baud Rates of CANopen Network*
ulCanOpenFlags	UINT32	CANopen Flags BIT 0: 29-BIT IDENTIFIER DISABLED/ ENABLED Not supported yet, set to zero BIT 1- 3: Reserved for further use, set to zero (BIT4 up to BIT10 are only applicable in Standard Mode) BIT 4: Evaluate Vendor ID DISABLED/ENABLED BIT 5: Evaluate Product Code DISABLED/ENABLED BIT 6: Evaluate Serial Number DISABLED/ENABLED BIT 7: Evaluate Revision Number DISABLED/ENABLED BIT 8: Evaluate Device Type DISABLED/ENABLED BIT 9: Evaluate Object Size DISABLED/ENABLED BIT 10: Evaluate PDO Count DISABLED/ENABLED BIT 11 - 15: Reserved for further use, set to zero BIT 16: Disable Send COS Synchronous Acyclic BIT 17: Disable Send COS Manufacturer Spec. BIT 18: Disable Send COS Profile Spec. BIT 19 - 24: Reserved for further use, set to zero BIT 25: Hold last state BIT 26 - 28: Reserved for further use, set to zero BIT 29: Extended Mode Flag BIT 30 - 32: Reserved for further use, set to zero	Flags
`tStdBusParam` or `tExtBusParam`	union	Depending on BIT 29 either standard bus parameter structure (BIT 29=0) or extended bus parameter structure (BIT 29=1), see below	-
ul29BitCode	UINT32	29Bit Acceptance Code	
ul29BitMask	UINT32	29Bit Acceptance Mask	

Table 45: Bus parameter structure CANOPEN_SLAVE_BUSPARAM_DATA_T

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The variable `ulSlaveNodeId` indicating the node ID of the CANopen slave is required for the addressing of the device at the bus and has to be unique in the network. Therefore it is not allowed to use this number two times in the same network. Allowed values range from 1 to 127.

The baud rate of the CANopen network can be set using the `ulBaudRate` variable. The settings listed in the following table are applicable:

Value	Corresponding Baud Rate of CANopen Network
0	1 MBaud
1	800 KBaud
2	500 KBaud
3	250 KBaud
4	125 KBaud
5	100 KBaud (this value is officially not defined in the CAN specifications!)
6	50 KBaud
7	20 KBaud
8	10 KBaud
255	Auto-Detection

Table 46: Codes and Corresponding Baud Rates of CANopen Network

The standard bus parameter structure `CANOPEN_SLAVE_STD_BUSPARAM_DATA_T` and the extended bus parameter structure `CANOPEN_SLAVE_EXT_BUSPARAM_DATA_T` are described in *Table 36: Standard bus parameter structure CANOPEN_SLAVE_STD_BUSPARAM_DATA_T* on page 69 and in *Table 39: Extended bus parameter structure CANOPEN_SLAVE_EXT_BUSPARAM_DATA_T* on page 71.

The following table on page 80 explains the meaning of the CANopen Flags in a more detailed manner:

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Explanation of Parameter `ulCanOpenFlags`				
Bit #	**Name**	**Comment**	**Applicable for Standard Mode**	**Applicable for Extended Mode**
0	29 bit identifier DISABLED/ENABLED	Currently, 29 bit identifiers are not supported. Therefore set this value to 0.	x	x
4	Evaluate Vendor ID DISABLED/ENABLED	The `ulVendorId` parameter provides the value for the Vendor ID entry in the object dictionary of the CANopen slave (Object 0x1018, sub-index 1) if bit 4 in parameter `ulCanopenFlags` is set. Otherwise, the vendor ID is set to zero.	x	
5	Evaluate Product Code DISABLED/ENABLED	The `ulProductCode` parameter provides the value for the product code entry in the object dictionary of the CANopen slave (Object 0x1018, sub-index 2) if bit 5 in parameter `ulCanopenFlags` is set. Otherwise, the product code is set to zero.	x	
6	Evaluate Serial Number DISABLED/ENABLED	The `ulSerialNumber` parameter provides the value for the serial number entry in the object dictionary of the CANopen slave (Object 0x1018, sub-index 4) if bit 6 in parameter `ulCanopenFlags` is set. Otherwise, the serial number is set to zero.	x	
7	Evaluate Revision Number DISABLED/ENABLED	The `ulRevisionNumber` parameter provides the value for the revision number entry in the object dictionary of the CANopen slave (Object 0x1018, sub-index 3) if bit 7 in parameter `ulCanopenFlags` is set. Otherwise, the revision number is set to default.	x	
8	Evaluate Device Type DISABLED/ENABLED		x	
9	Evaluate Object Size DISABLED/ENABLED		x	
10	Evaluate PDO Count DISABLED/ENABLED		x	
16	Send COS Synchronous Acyclic DISABLED/ENABLED	No automatic transmission of TxPDOs in transmission mode 0, else PDO sent automatically with start node and on data change with next SYNC.	x	x
17	Send COS Manufacturer Spec. DISABLED/ENABLED	No automatic transmission of TxPDOs in transmission mode 254, else PDO sent automatically with start node and on data change.	x	x
18	Send COS Profile Spec. DISABLED/ENABLED	No automatic transmission of TxPDOs in transmission mode 255, else PDO sent automatically with start node and on data change.	x	x
25	Hold last state	Hold last data in case of not operational, else data is cleared.	x	x
29	Extended mode flag	The extended mode flag switches on and off the Extended Mode.	x	x

Table 47: Explanation of Parameter `ulCanOpenFlags`

The following applies for filtering of 29 bit CANopen-IDs (only supported in Data Link Layer/CAN DL Task):

A receive filter for the COB-IDs can be defined.

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`ul29BitMask`

Here it is possible to define the bits, the filter uses. In other words: All bits currently not set will not be filtered out.

`ul29BitCode`

Those are the bits set to filter the IDs. Those bits must have the value ‘1’ in the acceptance code and the reaching COB-ID to pass the filter. If a bit is not set in the **Acceptance Mask**, the filter will pass the message anyway.

Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_STD_BUSPARAM_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_STD_BUSPARAM_DATA_Ttag
  CANOPEN_SLAVE_STD_BUSPARAM_DATA_T;
/** type of <code>CANOPEN_SLAVE_EXT_BUSPARAM_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_EXT_BUSPARAM_DATA_Ttag
  CANOPEN_SLAVE_EXT_BUSPARAM_DATA_T;
/** type of <code>CANOPEN_SLAVE_BUSPARAM_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_BUSPARAM_DATA_Ttag
  CANOPEN_SLAVE_BUSPARAM_DATA_T;

struct CANOPEN_SLAVE_STD_BUSPARAM_DATA_Ttag
{
  TLR_UINT32 ulVendorId;       /* Vendor ID              */
  TLR_UINT32 ulProductCode;    /* Product code           */
  TLR_UINT32 ulSerialNumber;   /* Serial number          */
  TLR_UINT32 ulRevisionNumber; /* Revision number        */
  TLR_UINT32 ulDeviceType;     /* Device Type            */

  TLR_UINT8  bObject2000Size;  /* Size of object 2000    */
  TLR_UINT8  bObject2001Size;  /* Size of object 2001    */
  TLR_UINT8  bObject2002Size;  /* Size of object 2002    */
  TLR_UINT8  bObject2003Size;  /* Size of object 2003    */

  TLR_UINT8  bObject2200Size;  /* Size of object 2200    */
  TLR_UINT8  bObject2201Size;  /* Size of object 2201    */
  TLR_UINT8  bObject2202Size;  /* Size of object 2202    */
  TLR_UINT8  bObject2203Size;  /* Size of object 2203    */

  TLR_UINT16 usNumOfRxPdo;     /* Number of receive PDOs  */
  TLR_UINT16 usNumOfTxPdo;     /* Number of transmit PDOs */

  TLR_UINT32 aulReserved[2];   /* Reserved, set to zero   */

};

struct CANOPEN_SLAVE_EXT_BUSPARAM_DATA_Ttag
{
  TLR_UINT16 usNumOfRxPdo;     /* Number of receive PDOs  */
  TLR_UINT16 usNumOfTxPdo;     /* Number of transmit PDOs */
  TLR_UINT32 aulReserved[9];   /* Reserved, set to zero   */
};

/*****************************************************************************/
/** type of <code>CANOPEN_APS_SET_CONFIGURATION_REQ_DATA_Ttag</code> */
typedef struct CANOPEN_APS_SET_CONFIGURATION_REQ_DATA_Ttag
  CANOPEN_APS_SET_CONFIGURATION_REQ_DATA_T;

#define CANOPEN_APS_SYS_FLAG_COM_CONTROLLED_RELEASE 0x00000001L /* Automatic start    */
#define CANOPEN_APS_SYS_FLAG_IO_STATUS_ENABLED      0x00000002L /* Not supported      */
#define CANOPEN_APS_SYS_FLAG_IO_STATUS_32_BIT       0x00000004L /* Not supported      */

#define CANOPEN_APS_SYS_FLAG_ADDRESS_SWITCH         0x00000010L /* Switch for address */
#define CANOPEN_APS_SYS_FLAG_BAUD_SWITCH            0x00000020L /* Switch for baud    */
```


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```
#define CANOPEN_APS_WD_OFF                          0x00000000L /* Watchdog disabled */
#define CANOPEN_APS_WD_MIN_TIMEOUT                  0x00000014L /* Minimum watchdog  */
#define CANOPEN_APS_WD_MAX_TIMEOUT                  0x0000FFFFL /* Maximum watchdog  */

#define CANOPEN_SLAVE_MIN_SLAVE_NODE_ID  1
#define CANOPEN_SLAVE_MAX_SLAVE_NODE_ID  127

#define CANOPEN_SLAVE_CFG_BAUD_1000    0x00000000L   /* 1MBaud   */
#define CANOPEN_SLAVE_CFG_BAUD_800     0x00000001L   /* 800kBaud */
#define CANOPEN_SLAVE_CFG_BAUD_500     0x00000002L   /* 500kBaud */
#define CANOPEN_SLAVE_CFG_BAUD_250     0x00000003L   /* 250kBaud */
#define CANOPEN_SLAVE_CFG_BAUD_125     0x00000004L   /* 125kBaud */
#define CANOPEN_SLAVE_CFG_BAUD_100     0x00000005L   /* 100kBaud */
#define CANOPEN_SLAVE_CFG_BAUD_50      0x00000006L   /* 50kBaud  */
#define CANOPEN_SLAVE_CFG_BAUD_20      0x00000007L   /* 20kBaud  */
#define CANOPEN_SLAVE_CFG_BAUD_10      0x00000008L   /* 10kBaud  */
#define CANOPEN_SLAVE_CFG_BAUD_AUTO_DETECTION 0x000000FFL /* Auto-Baud detection */

#define CANOPEN_SLAVE_STD_CFG_DEF_OBJECT_SIZE  128 /* Default object size in std mode */

#define CANOPEN_SLAVE_CFG_MAX_RXPDO            256 /* Maximum number of RxPDO    */
#define CANOPEN_SLAVE_CFG_MAX_TXPDO            256 /* Maximum number of TxPDO    */

struct CANOPEN_SLAVE_BUSPARAM_DATA_Ttag
{
  TLR_UINT32 ulSlaveNodeId;  /* Node ID       */
  TLR_UINT32 ulBaudrate;     /* Baud-rate     */
  TLR_UINT32 ulCanOpenFlags; /* CANopen flags */

   union
  {
    CANOPEN_SLAVE_STD_BUSPARAM_DATA_T tStdBusParam; /* Parameter for standard mode*/
    CANOPEN_SLAVE_EXT_BUSPARAM_DATA_T tExtBusParam; /* Parameter for extended mode*/

  } uMode;

  TLR_UINT32 ul29BitCode; /* 29Bit Code */
  TLR_UINT32 ul29BitMask; /* 29Bit Mask */

};

struct CANOPEN_APS_SET_CONFIGURATION_REQ_DATA_Ttag
{
  TLR_UINT32 ulSystemFlags;               /* System flags  */
  TLR_UINT32 ulWdgTime;                   /* Watchdog time */
  CANOPEN_SLAVE_BUSPARAM_DATA_T tBusParam; /* Bus parameter */

};

/*****************************************************************************/
/** type of <code>CANOPEN_APS_SET_CONFIGURATION_REQ_Ttag</code> */
typedef struct CANOPEN_APS_SET_CONFIGURATION_REQ_Ttag
  CANOPEN_APS_SET_CONFIGURATION_REQ_T;

struct CANOPEN_APS_SET_CONFIGURATION_REQ_Ttag
{
  TLR_PACKET_HEADER_T                      tHead;  /** packet header */
  CANOPEN_APS_SET_CONFIGURATION_REQ_DATA_T  tData;  /** packet data   */
};

/*****************************************************************************/
```


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Packet Description

Structure Information CANOPEN_APS_PCK_SET_CONFIGURATION_REQ_T				Type: Request
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	Structure TLR_PACKET_HEADER_T			
	ulDest	UINT32	0x20/ QUE_CANOPENAPS	Destination Queue-Handle of CANopen slave-task Process Queue
	ulSrc	UINT32	0 ... 2^{32}-1	Source Queue-Handle of AP-task Process Queue
	ulDestId	UINT32	ulCANOPESLVT0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process
	ulSrcId	UINT32	ulAPSS0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	68	Packet Data Length (In Bytes)
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification As Unique Number
	ulSta	UINT32		*See section 6.1.1 Codes of the CANopen-APS-Task*
	ulCmd	UINT32	0x00002E04	CANOPEN_APS_SET_CONFIGURATION_REQ - Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch
tData	Structure CANOPEN_APS_SET_CONFIGURATION_REQ_DATA_T			
	ulSystemFlags	UINT32	 0 1	System Flags BIT 0: AUTOSTART / APPLICATION CONTROLLED communication with a controller after a device start is allowed without BUS_ON flag, but the communication will be interrupted if the BUS_ON flag changes state to 0 communication with controller is allowed only with the BUS_ON flag. BIT 1: I/O STATUS DISABLED/ ENABLED Not supported yet BIT 2: IO STATUS 32 BIT Not supported yet BIT 3: Reserved for further use, set to zero BIT 4: ADDRESS_SWITCH Should be set when hardware address switch is used and there is no TAG present. BIT 5: BAUD_SWITCH Should be set when hardware baudrate switch is used and there is no TAG present. BIT 6 - 31: Reserved for further use, set to zero
	ulWdgTime	UINT32	 0 20 .. 65535	Watchdog supervision Watchdog supervision deactivated Watchdog time in milliseconds
	tBusParam	CANOPEN_SLAVE_BUSPARAM_DATA_T		Bus parameter structure

Table 48: CANOPEN_APS_PCK_SET_CONFIGURATION_REQ – Set Warmstart Parameter Request

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Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_APS_SET_CONFIGURATION_CNF_Ttag</code> */
typedef struct CANOPEN_APS_SET_CONFIGURATION_CNF_Ttag
  CANOPEN_APS_SET_CONFIGURATION_CNF_T;

struct CANOPEN_APS_SET_CONFIGURATION_CNF_Ttag
{
  TLR_PACKET_HEADER_T tHead;  /** packet header */
};
/*****************************************************************************/
```

Packet Description

Structure Information CANOPEN_APS_PCK_SET_CONFIGURATION_CNF_T				**Type: Confirmation**
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	Structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle, untouched
	ulSrc	UINT32		Source Queue-Handle, untouched
	ulDestId	UINT32	ulAPSS0Id	Destination End Point Identifier, untouched
	ulSrcId	UINT32	ulCANOPESLVT0Id	Source End Point Identifier, untouched
	ulLen	UINT32	0	Packet Data Length (In Bytes)
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as Unique Number
	ulSta	UINT32		*See section 6.1.1 Codes of the CANopen-APS-Task*
	ulCmd	UINT32	0x00002E05	CANOPEN_APS_SET_CONFIGURATION_CNF - Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch

Table 49: CANOPEN_APS_PCK_SET_CONFIGURATION_CNF_T – Set Warmstart Parameter Confirmation

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5.2 The CANopen Slave-Task

To get the handle of the process queue of the CANopen slave-task the Macro `TLR_QUE_IDENTIFY()` needs to be used.

ASCII queue name	Description
"QUE_CANOPENSLV"	Name of the CANopen slave-task process queue
"QUE_COS_ODV3"	Name of the CANopen slave- Task ODV3 process queue

Table 50 CANopen Slave-Task Process Queue

The returned handle has to be used as value `ulDest` in all request packets to be sent to the CANopen slave-Task. This handle is the same handle that has to be used in conjunction with the macros like `TLR_QUE_SENDPACKET_FIFO/LIFO()` for sending a packet to the CANopen slave-Task.

Restrictions of Usage of Packets (concerning LOM and LFW)

The CANopen Slave Protocol Stack V3 supports two different application situations:

- Loadable Firmware (*LFW*)
- Linkable Object Modules (*LOM*)

Not all packets can be applied without any restrictions in both models. Some packets only make sense for one of these application situations or cannot be executed when the 'Configuration Lock' flag is set. This section informs about these restrictions of usage.

The following packet of the CANopen Slave-Task is only available for working with Linkable Object Modules:

`CANOPEN_SLAVE_SET_API_PARAM_REQ/CNF` – Set API Parameter

`CANOPEN_SLAVE_SET_BUSPARAM_REQ/CNF` – Set Bus Parameters

The following packet of the CANopen Slave-Task will be denied if the 'Configuration Lock' flag is set:

`CANOPEN_SLAVE_SET_EVENTS_INDICATED_REQ/CNF` – Set Events Indicated Request

The following table lists all packets of the CANopen Slave-Task and specifies, whether they can be used with LFW, with LOM and whether they will be denied if the '*Configuration Lock*' flag is set.

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Section	Name	LFW	LOM	Denied on Cfg. Lock
5.2.1	CANOPEN_SLAVE_REGISTER_REQ/CNF – Register Application	0	x	x
5.2.2	CANOPEN_SLAVE_STARTSTOP_REQ/CNF – Start/Stop CANopen Network	x	x	x
5.2.3	CANOPEN_SLAVE_INITIALIZE_REQ/CNF – Initialization of CANopen Slave	0	x	x
5.2.4	CANOPEN_SLAVE_EXCHANGE_DATA_REQ/CNF – Exchange Data	x	x	x
5.2.5	CANOPEN_SLAVE_STATE_CHANGE_IND/RES – Change of Task State Indication	0	x	x
5.2.6	CANOPEN_SLAVE_SEND_EMCY_REQ/CNF – Send Emergency Message	x	x	x
5.2.7	CANOPEN_SLAVE_SEND_EMCY_IND/RES – Emergency Message Indication	x	x	x
5.2.8	CANOPEN_SLAVE_SET_NMT_STATE_REQ/CNF – Set NMT State	x	x	x
5.2.9	CANOPEN_SLAVE_SET_BUSPARAM_REQ/CNF – Set Bus Parameters	0	x	0
5.2.10	CANOPEN_SLAVE_SEND_TIME_STAMP_REQ/CNF – Send Time Stamp	x	x	x
5.2.11	CANOPEN_SLAVE_RECV_TIME_STAMP_IND/RES – Receive Time Stamp Indication	x	x	x
5.2.12	CANOPEN_SLAVE_SEND_TXPDO_REQ – Send TxPDO Request	x	x	x
5.2.13	CANOPEN_SLAVE_RECV_RXPDO_REQ/CNF – Receive RxPDO Request	x	x	x
5.2.14	CANOPEN_SLAVE_RECV_RXPDO_IND/RES – Receive RxPDO Indication	x	x	x
5.2.15	CANOPEN_SLAVE_SET_EVENTS_INDICATED_REQ/CNF – Set Events Indicated Request	x	x	0
5.2.16	CANOPEN_SLAVE_GET_IO_INFO_REQ/CNF – Get I/O Info	x	x	x
5.2.17	CANOPEN_SLAVE_SET_API_PARAM_REQ/CNF – Set API Parameter	0	x	x
5.2.18	CANOPEN_SLAVE_NMT_STATE_CHANGE_IND/RES – NMT State Change Indication	x	x	x
5.2.19	CANOPEN_SLAVE_ERR_CTRL_EVENT_IND/RES – Error Control Event Indication	x	x	x
5.2.20	CANOPEN_SLAVE_NMT_COMMAND_IND/RES – NMT Command Indication	x	x	x
5.2.21	CANOPEN_SLAVE_GET_BUSPARAM_REQ/CNF – Get Bus Parameters	0	x	x
5.2.22	CANOPEN_SLAVE_SET_WATCHDOG_FAIL_REQ/CNF – Set Watchdog Fail	0	x	x
5.2.23	CANOPEN_SLAVE_SETUP_PDO_INDICATION_REQ/CNF – Setup PDO Indication	x	x	x
5.2.24	CANOPEN_SLAVE_RECEIVE_PDO_IND/RES – Receive PDO Indication	x	x	x

Table 51: Packets of CANopen Slave Protocol Stack V3 and Restrictions of Usage

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5.2.1 CANOPEN_SLAVE_REGISTER_REQ/CNF – Register Application

This packet is used in order to register to the CANopen slave task. After this request is performed successfully, indication packets are sent from the CANopen slave task to the source queue of this request packet.

Note: Use this packet only when working with linkable object modules. It has not been designed for usage in the context of loadable firmware.

Note: This packet is used by the AP-task only and will not be routed from the user application to the CANopen Slave-task.

Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_REGISTER_REQ_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_REGISTER_REQ_DATA_Ttag
  CANOPEN_SLAVE_REGISTER_REQ_DATA_T;

struct CANOPEN_SLAVE_REGISTER_REQ_DATA_Ttag
{
  TLR_UINT8 bReserved; /* Reserved for further use, set to zero*/

};
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_REGISTER_REQ_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_REGISTER_REQ_Ttag
  CANOPEN_SLAVE_PACKET_REGISTER_REQ_T;

/** Structure of task command application register request*/
struct CANOPEN_SLAVE_PACKET_REGISTER_REQ_Ttag
{
  TLR_PACKET_HEADER_T               tHead;  /** packet header.       */
  CANOPEN_SLAVE_REGISTER_REQ_DATA_T tData;  /** packet request data. */

};
/*****************************************************************************/
```


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Packet Description

Structure Information CANOPEN_SLAVE_PACKET_REGISTER_REQ_T				Type: Request
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	Structure TLR_PACKET_HEADER_T			
	ulDest	UINT32	QUE_CANOPENSLV	Destination Queue-Handle of CANopen slave-Task Process Queue
	ulSrc	UINT32	0 ... 2^{32}-1	Source Queue-Handle of AP-Task Process Queue
	ulDestId	UINT32	ulCANOPENSLV0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process
	ulSrcId	UINT32	ulAPSS0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	4	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32	0	See section 6.2 *"Codes of the CANopen Slave-Task"*
	ulCmd	UINT32	0x2900	CANOPEN_SLAVE_REGISTER_REQ - Command
	ulExt	UINT32	0	Reserved
	ulRout	UINT32	x	Routing Information
tData	structure CANOPEN_SLAVE_REGISTER_REQ_DATA_T			
	bReserved	UINT32	0	Reserved for further use, set to zero

Table 52: CANOPEN_SLAVE_PACKET_APP_REGISTER_REQ_T – Register Application Request

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Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_REGISTER_CNF_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_REGISTER_CNF_DATA_Ttag
  CANOPEN_SLAVE_REGISTER_CNF_DATA_T;

struct CANOPEN_SLAVE_REGISTER_CNF_DATA_Ttag
{
  TLR_UINT8 bReserved; /* Reserved for further use */
};

/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_REGISTER_CNF_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_REGISTER_CNF_Ttag
  CANOPEN_SLAVE_PACKET_REGISTER_CNF_T;

/** Structure of task command application register confirmation */
struct CANOPEN_SLAVE_PACKET_REGISTER_CNF_Ttag
{
  TLR_PACKET_HEADER_T               tHead; /** packet header.            */
  CANOPEN_SLAVE_REGISTER_CNF_DATA_T tData; /** packet confirmation data. */
};
/*****************************************************************************/
```

Packet Description

Structure Information CANOPEN_SLAVE_PACKET_APP_REGISTER_CNF				**Type: Confirmation**
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	Structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle, untouched
	ulSrc	UINT32		Source Queue-Handle, untouched
	ulDestId	UINT32	ulAPSS0Id	Destination End Point Identifier, untouched
	ulSrcId	UINT32	ulCANOPENSLV0Id	Source End Point Identifier, untouched
	ulLen	UINT32	4	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32		See section 6.2 *"Codes of the CANopen Slave-Task"*
	ulCmd	UINT32	0x2901	CANOPEN_SLAVE_REGISTER_CNF - Command
	ulExt	UINT32	0	Extension, reserved
	ulRout	UINT32	x	Routing Information, do not change
tData	Structure CANOPEN_SLAVE_APP_REGISTER_CNF_DATA_T			
	bReserved	UINT32	0	Reserved for further use, set to zero

Table 53: CANOPEN_SLAVE_PACKET_APP_REGISTER_CNF_T – Register Application Confirmation

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5.2.2 CANOPEN_SLAVE_STARTSTOP_REQ/CNF – Start/Stop CANopen Network

This packet starts or stops the communication with the CANopen network, depending on the value of the `ulMode` parameter.

- If the `ulMode` parameter has the value 0 and the current NMT State is either *Pre-operational* state or *Operational* state, the NMT State will switch to *Stopped* state.
- If the `ulMode` parameter has the value 1 and the current NMT State is either *Pre-operational* state or *Stopped* state, the NMT State will switch to *Operational* state.

The BUS-ON/BUS-OFF flag is set accordingly (`ulMode=0`: BUS-OFF `ulMode=1`: BUS-ON)

For more information about NMT States, see section 4.4.1”*NMT Slave State Machine*”.

Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_STARTSTOP_REQ_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_STARTSTOP_REQ_DATA_Ttag
  CANOPEN_SLAVE_STARTSTOP_REQ_DATA_T;

#define CANOPEN_SLAVE_STOP_CANOPEN     0x00000000L  /* Stop CANopen  */
#define CANOPEN_SLAVE_START_CANOPEN    0x00000001L  /* Start CANopen */

/** Structure of task command start/stop CANopen request data */
struct CANOPEN_SLAVE_STARTSTOP_REQ_DATA_Ttag
{
  TLR_UINT32 ulMode; /* Start or stop CANopen */
};

/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_STARTSTOP_REQ_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_STARTSTOP_REQ_Ttag
  CANOPEN_SLAVE_PACKET_STARTSTOP_REQ_T;

/** Structure of task command start/stop CANopen request */
struct CANOPEN_SLAVE_PACKET_STARTSTOP_REQ_Ttag
{
  TLR_PACKET_HEADER_T                tHead;  /** packet header.       */
  CANOPEN_SLAVE_STARTSTOP_REQ_DATA_T tData;  /** packet request data. */

};
/*****************************************************************************/
```


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Packet Description

Structure Information CANOPEN_SLAVE_PACKET_STARTSTOP_REQ_T				Type: Request
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	Structure TLR_PACKET_HEADER_T			
	ulDest	UINT32	0x20/ QUE_CANOPEN SLV	Destination Queue-Handle of CANopen slave-Task Process Queue
	ulSrc	UINT32	0 ... 2^{32}-1	Source Queue-Handle of AP-Task Process Queue
	ulDestId	UINT32	ulCANOPENSL V0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process
	ulSrcId	UINT32	ulAPSS0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	4	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32	0	See section 6.2 *"Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x00002902	CANOPEN_SLAVE_STARTSTOP_REQ - Command
	ulExt	UINT32	0	Reserved
	ulRout	UINT32	x	Routing Information
tData	Structure CANOPEN_SLAVE_STARTSTOP_REQ_DATA_T			
	ulMode	UINT32	 0 1	Depending on this assignment, communication is either started or stopped: Stop CANopen Start CANopen

Table 54: CANOPEN_SLAVE_PACKET_STARTSTOP_REQ_T – Start/Stop Communication Request

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Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_STARTSTOP_CNF_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_STARTSTOP_CNF_DATA_Ttag
  CANOPEN_SLAVE_STARTSTOP_CNF_DATA_T;

#define CANOPEN_SLAVE_STOP_CANOPEN     0x00000000L  /* Stop CANopen  */
#define CANOPEN_SLAVE_START_CANOPEN    0x00000001L  /* Start CANopen */

/** Structure of task command start/stop CANopen confirmation data */
struct CANOPEN_SLAVE_STARTSTOP_CNF_DATA_Ttag
{
  TLR_UINT32 ulMode; /* Start or stop CANopen */
};

/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_STARTSTOP_CNF_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_STARTSTOP_CNF_Ttag
  CANOPEN_SLAVE_PACKET_STARTSTOP_CNF_T;

/** Structure of task command start/stop CANopen confirmation */
struct CANOPEN_SLAVE_PACKET_STARTSTOP_CNF_Ttag
{
  TLR_PACKET_HEADER_T                tHead;  /** packet header.            */
  CANOPEN_SLAVE_STARTSTOP_CNF_DATA_T tData;  /** packet confirmation data. */
};
/*****************************************************************************/
```

Packet Description

Structure Information CANOPEN_SLAVE_PACKET_STARTSTOP_CNF_T				**Type: Confirmation**
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	Structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle, untouched
	ulSrc	UINT32		Source Queue-Handle, untouched
	ulDestId	UINT32	ulAPSS0Id	Destination End Point Identifier, untouched
	ulSrcId	UINT32	ulCANOPENSLV0Id	Source End Point Identifier, untouched
	ulLen	UINT32	4	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32		See section 6.2 *"Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x00002903	CANOPEN_SLAVE_STARTSTOP_CNF - Command
	ulExt	UINT32		Extension, reserved
	ulRout	UINT32		Routing Information, do not change
tData	structure CANOPEN_SLAVE_STARTSTOP_CNF_DATA_T			
	ulMode	UINT32		Depending on this assignment, communication is either started or stopped:
			0	Stop CANopen
			1	Start CANopen

Table 55: CANOPEN_SLAVE_PACKET_STARTSTOP_CNF_T – Start/Stop Communication Confirmation

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5.2.3 CANOPEN_SLAVE_INITIALIZE_REQ/CNF – Initialization of CANopen Slave

This command is used in order to reset and initialize the CANopen slave.

You can read in section 4.4.1 “*NMT Slave State Machine*” what happens in detail during the initialization process of the CANopen Slave protocol stack.

If you are interested to know in detail what happens during the initialization process of the CANopen Slave protocol stack, you should read section 4.4.1 “*NMT Slave State Machine*”.

Note: Use this packet preferably when working with linkable object modules. In the context of loadable firmware we recommend to use ‘config reload’ instead.

Note: This command does not delete configuration databases. If the CANopen Slave is configured by configuration database, this configuration is reloaded again after the initialize command is completed.

Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_INITIALIZE_REQ_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_INITIALIZE_REQ_DATA_Ttag
  CANOPEN_SLAVE_INITIALIZE_REQ_DATA_T;

/** Structure of task command delete configuration CANopenrequest data */
struct CANOPEN_SLAVE_INITIALIZE_REQ_DATA_Ttag
{
  TLR_UINT32 ulReserved; /* Reserved fur further use, set to zero */
};

/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_INITIALIZE_REQ_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_INITIALIZE_REQ_Ttag
  CANOPEN_SLAVE_PACKET_INITIALIZE_REQ_T;

/** Structure of task command delete configuration request */
struct CANOPEN_SLAVE_PACKET_INITIALIZE_REQ_Ttag
{
  TLR_PACKET_HEADER_T                 tHead;  /** packet header.       */
  CANOPEN_SLAVE_INITIALIZE_REQ_DATA_T tData;  /** packet request data. */
};
/*****************************************************************************/
```


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Packet Description

Structure Information CANOPEN_SLAVE_PACKET_INITIALIZE_REQ_T				Type: Request
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	Structure TLR_PACKET_HEADER_T			
	ulDest	UINT32	0x20/ QUE_CANOPEN SLV	Destination Queue-Handle of CANopen slave-Task Process Queue
	ulSrc	UINT32	0 ... 2^{32}-1	Source Queue-Handle of AP-Task Process Queue
	ulDestId	UINT32	ulCANOPENSL V0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process
	ulSrcId	UINT32	ulAPSS0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	4	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32	0	See section 6.2 *"Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x2904	CANOPEN_SLAVE_SLAVE_REQ – Command
	ulExt	UINT32	0	Reserved
	ulRout	UINT32	x	Routing Information
tData	Structure CANOPEN_SLAVE_INITIALIZE_REQ_DATA_T			
	ulReserved	UINT32	0	Reserved for further use, set to zero

Table 56: CANOPEN_SLAVE_PACKET_INITIALIZE_REQ_T – Initialization of CANopen Slave Request

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Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_INITIALIZE_CNF_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_INITIALIZE_CNF_DATA_Ttag
  CANOPEN_SLAVE_INITIALIZE_CNF_DATA_T;

/** Structure of task command delete configuration confirmation data */
struct CANOPEN_SLAVE_INITIALIZE_CNF_DATA_Ttag
{
  TLR_UINT32 ulReserved; /* Reserved fur further use */
};

/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_INITIALIZE_CNF_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_INITIALIZE_CNF_Ttag
  CANOPEN_SLAVE_PACKET_INITIALIZE_CNF_T;

/** Structure of task command delete configuration confirmation */
struct CANOPEN_SLAVE_PACKET_INITIALIZE_CNF_Ttag
{
  TLR_PACKET_HEADER_T                 tHead;  /** packet header.            */
  CANOPEN_SLAVE_INITIALIZE_CNF_DATA_T tData;  /** packet confirmation data. */
};
/*****************************************************************************/
```

Packet Description

Structure Information CANOPEN_SLAVE_PACKET_INITIALIZE_CNF_T				**Type: Confirmation**
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	Structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle, untouched
	ulSrc	UINT32		Source Queue-Handle, untouched
	ulDestId	UINT32	ulAPSS0Id	Destination End Point Identifier, untouched
	ulSrcId	UINT32	ulCANOPENSLV0Id	Source End Point Identifier, untouched
	ulLen	UINT32	4	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32		See section 6.2 *"Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x2905	CANOPEN_SLAVE_INITIALIZE_CNF- Command
	ulExt	UINT32		Extension, reserved
	ulRout	UINT32		Routing Information, do not change
tData	Structure CANOPEN_SLAVE_INITIALIZE_CNF_DATA_T			
	ulReserved	UINT32	0	Reserved for further use, set to zero

Table 57: CANOPEN_SLAVE_PACKET_INITIALIZE_CNF_T – Initialization of CANopen Slave Confirmation

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5.2.4 CANOPEN_SLAVE_EXCHANGE_DATA_REQ/CNF – Exchange Data

This packet can be used to exchange send and receive object data with the CANopen network. It can be used instead of exchanging data with the input and output image of the DPM. With each packet, data of one receive object can be read and data of one send object can be written.

This packet is only applicable in Standard Mode.

Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_EXCHANGE_DATA_REQ_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_EXCHANGE_DATA_REQ_DATA_Ttag
  CANOPEN_SLAVE_EXCHANGE_DATA_REQ_DATA_T;

/** Structure of task command start/stop CANopen request data */
struct CANOPEN_SLAVE_EXCHANGE_DATA_REQ_DATA_Ttag
{
  TLR_UINT32 ulRecvIndex;     /* Object index for recv data     */
  TLR_UINT32 ulRecvSubIndex;  /* Object sub-index for recv data */
  TLR_UINT32 ulRecvDataCnt;   /* Recv data count                */

  TLR_UINT32 ulSendIndex;    /* Object index for send Data     */
  TLR_UINT32 ulSendSubIndex; /* Object sub-index for send Data */
  TLR_UINT32 ulSendDataCnt;  /* Send data count                */

  TLR_UINT8  abSendData[CANOPEN_SLAVE_MAX_SEND_SUB_IDX];
};

#define CANOPEN_SLAVE_EXCHANGE_DATA_HEAD_SIZE (6 * sizeof(TLR_UINT32))

/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_EXCHANGE_DATA_REQ_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_EXCHANGE_DATA_REQ_Ttag
  CANOPEN_SLAVE_PACKET_EXCHANGE_DATA_REQ_T;

/** Structure of task command exchange data request*/
struct CANOPEN_SLAVE_PACKET_EXCHANGE_DATA_REQ_Ttag
{
  TLR_PACKET_HEADER_T                    tHead;   /** packet header.       */
  CANOPEN_SLAVE_EXCHANGE_DATA_REQ_DATA_T tData;  /** packet request data. */
};
/*****************************************************************************/
```


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Packet Description

Structure Information CANOPEN_SLAVE_PACKET_EXCHANGE_DATA_REQ_T				Type: Request
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	Structure TLR_PACKET_HEADER_T			
	ulDest	UINT32	0x20/ QUE_CANOPEN SLV	Destination Queue-Handle of CANopen slave-Task Process Queue
	ulSrc	UINT32	0 ... 2^{32}-1	Source Queue-Handle of AP-Task Process Queue
	ulDestId	UINT32	ulCANOPENSL V0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process
	ulSrcId	UINT32	ulAPSS0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	24 .. 279	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32	0	See section 6.2 *"Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x290A	CANOPEN_SLAVE_EXCHANGE_DATA_REQ - Command
	ulExt	UINT32	0	Reserved
	ulRout	UINT32	x	Routing Information
tData	Structure CANOPEN_SLAVE_EXCHANGE_DATA_REQ_DATA_T			
	ulRecvIndex	UINT32	0x2200..0x2203	Receive object index
	ulRecvSub Index	UINT32	1.. 255	Receive object sub-index
	ulRecvData Cnt	UINT32	0 ..255	Number of data bytes to be read
	ulSendIndex	UINT32	0x2000..0x2003	Send object index
	ulSendSub Index	UINT32	1.. 255	Send object sub-index
	ulSendData Cnt	UINT32	0 ..255	Number of data bytes to be sent
	abSendData [255]	UINT8[]		Data to be sent

Table 58: CANOPEN_SLAVE_PACKET_EXCHANGE_DATA_REQ_T – Exchange Data Request

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Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_EXCHANGE_DATA_CNF_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_EXCHANGE_DATA_CNF_DATA_Ttag
  CANOPEN_SLAVE_EXCHANGE_DATA_CNF_DATA_T;

/** Structure of task command start/stop CANopen confirmation data */
struct CANOPEN_SLAVE_EXCHANGE_DATA_CNF_DATA_Ttag
{
  TLR_UINT32 ulRecvIndex;     /* Object index for recv data     */
  TLR_UINT32 ulRecvSubIndex;  /* Object sub-index for recv data */
  TLR_UINT32 ulRecvDataCnt;   /* Recv data count                */

  TLR_UINT32 ulSendIndex;    /* Object index for send Data     */
  TLR_UINT32 ulSendSubIndex; /* Object sub-index for send Data */
  TLR_UINT32 ulSendDataCnt;  /* Send data count                */

  TLR_UINT8  abRecvData[CANOPEN_SLAVE_MAX_RECV_SUB_IDX];
};

#define CANOPEN_SLAVE_EXCHANGE_DATA_HEAD_SIZE (6 * sizeof(TLR_UINT32))

/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_EXCHANGE_DATA_CNF_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_EXCHANGE_DATA_CNF_Ttag
  CANOPEN_SLAVE_PACKET_EXCHANGE_DATA_CNF_T;

/** Structure of task command exchange data confirmation */
struct CANOPEN_SLAVE_PACKET_EXCHANGE_DATA_CNF_Ttag
{
  TLR_PACKET_HEADER_T                    tHead;  /** packet header.            */
  CANOPEN_SLAVE_EXCHANGE_DATA_CNF_DATA_T tData;  /** packet confirmation data. */
};
/*****************************************************************************/
```


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Packet Description

Structure Information CANOPEN_SLAVE_PACKET_EXCHANGE_DATA_CNF				Type: Confirmation
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	Structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle, untouched
	ulSrc	UINT32		Source Queue-Handle, untouched
	ulDestId	UINT32	ulAPSS0Id	Destination End Point Identifier, untouched
	ulSrcId	UINT32	ulCANOPENSLV0Id	Source End Point Identifier, untouched
	ulLen	UINT32	24 .. 279	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32		See section 6.2 *"Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x290B	CANOPEN_SLAVE_EXCHANGE_DATA_CNF- Command
	ulExt	UINT32		Extension, reserved
	ulRout	UINT32		Routing Information, do not change
tData	structure CANOPEN_SLAVE_EXCHANGE_DATA_CNF_DATA_T			
	ulRecvIndex	UINT32	0x2200..0x2203	Receive object index
	ulRecvSubIndex	UINT32	1.. 255	Receive object sub-index
	ulRecvDataCnt	UINT32	0 ..255	Number data byte to be read
	ulSendIndex	UINT32	0x2000..0x2003	Send object index
	ulSendSubIndex	UINT32	1.. 255	Send object sub-index
	ulSendDataCnt	UINT32	0 ..255	Number data byte to be sent
	abRecvData[255]	UINT8[]		Receive data

Table 59: CANOPEN_SLAVE_PACKET_EXCHANGE_DATA_CNF_T –Exchange Data Confirmation

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5.2.5 CANOPEN_SLAVE_STATE_CHANGE_IND/RES – Change of Task State Indication

This indication packet signifies a change of the state of the CANopen slave-task. The indication delivers two important blocks containing status information about the CANopen slave, namely

- The slave state
- The extended slave state

These blocks delivering information about the change of state are described in detail below.

Note: Use this packet only when working with linkable object modules. It is not designed for usage in the context of loadable firmware.

Note: This indication is used by the AP-Task in order to set status information in the DPM and will not be routed to the user application.

In order to be able to receive this indication, the CANOPEN_SLAVE_REGISTER_REQ/CNF – Register Application request has to be executed by the AP-Task.

Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_STATE_CHANGE_IND_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_STATE_CHANGE_IND_DATA_Ttag
  CANOPEN_SLAVE_STATE_CHANGE_IND_DATA_T;

struct CANOPEN_SLAVE_STATE_CHANGE_IND_DATA_Ttag
{
  CANOPEN_SLAVE_SLAVE_STATE_T    tSlaveState;     /* Slave state    */
  CANOPEN_SLAVE_EXTENDED_STATE_T tExtendedState;  /* Extended state */
};

/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_STATE_CHANGE_IND_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_STATE_CHANGE_IND_Ttag
  CANOPEN_SLAVE_PACKET_STATE_CHANGE_IND_T;

struct CANOPEN_SLAVE_PACKET_STATE_CHANGE_IND_Ttag
{
  TLR_PACKET_HEADER_T                   tHead;  /** packet header.            */
  CANOPEN_SLAVE_STATE_CHANGE_IND_DATA_T tData;  /** packet request data.      */
};
/*****************************************************************************/
```


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Packet Description

Structure Information CANOPEN_SLAVE_PACKET_STATE_CHANGE_IND_T				Type: Indication
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	Structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle of AP-Task Process Queue
	ulSrc	UINT32		Source Queue-Handle of CANopen slave-Task Process Queue
	ulDestId	UINT32	ulAPSS0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process
	ulSrcId	UINT32	ulCANOPENSLV0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	112	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32		See section 6.2 *"Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x2912	CANOPEN_SLAVE_STATE_CHANGE_IND - Command
	ulExt	UINT32	0	Reserved
	ulRout	UINT32	x	Routing Information
tData	Structure CANOPEN_SLAVE_STATE_CHANGE_IND_DATA_T			
	tSlaveState	CANOPEN_SLAVE_SLAVE_STATE_T		Structure for slave state, see explanation below.
	tExtendedState	CANOPEN_SLAVE_EXTENDED_STATE_T		Structure for extended slave state, see explanation below.

Table 60: CANOPEN_SLAVE_PACKET_STATE_CHANGE_IND_T – Change of State Indication

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CANopen Slave State Structure Reference

```
typedef struct CANOPEN_SLAVE_SLAVE_STATE_Ttag
  CANOPEN_SLAVE_SLAVE_STATE_T;

#define CANOPEN_SLAVE_CAN_STATE_UNKNOWN         0x00000000L
#define CANOPEN_SLAVE_CAN_STATE_NOT_CONFIGURED  0x00000001L
#define CANOPEN_SLAVE_CAN_STATE_STOPPED         0x00000002L
#define CANOPEN_SLAVE_CAN_STATE_STARTED         0x00000003L
#define CANOPEN_SLAVE_CAN_STATE_RUNNING         0x00000004L

#define CANOPEN_SLAVE_STATE_FLAG_RDY            0x00000001L
#define CANOPEN_SLAVE_STATE_FLAG_RUN            0x00000002L
#define CANOPEN_SLAVE_STATE_FLAG_COM            0x00000004L
#define CANOPEN_SLAVE_STATE_FLAG_BUS_ON         0x00000008L
#define CANOPEN_SLAVE_STATE_FLAG_COMM_ERROR     0x00000010L
#define CANOPEN_SLAVE_STATE_FLAG_CAN_STARTED    0x00000100L

struct CANOPEN_SLAVE_SLAVE_STATE_Ttag
{
  TLR_UINT32  ulCanState;

  TLR_UINT32  aulUnused[2];

  TLR_UINT32  ulFlags;

  TLR_UINT32  ulErrorCount;
  TLR_UINT32  ulCommError;

  TLR_UINT32  ulRunLedState;
  TLR_UINT32  ulErrLedState;

  TLR_UINT32  ulRecvDataCnt;
  TLR_UINT32  ulSendDataCnt;

  TLR_UINT32  ulReserved;

};
```

`ulCanState`

This variable is organized as a bit field as described in the table below:

Bit	Name	Description
D4	**CANOPEN_SLAVE_CAN_STATE_RUNNING**	CAN State is *"Running"*
D3	**CANOPEN_SLAVE_CAN_STATE_STARTED**	CAN State is *"Started"*
D2	**CANOPEN_SLAVE_CAN_STATE_STOPPED**	CAN State is *"Stopped"*
D1	**CANOPEN_SLAVE_CAN_STATE_ NOT_CONFIGURED**	CAN State is *"Not configured"*
D0	**CANOPEN_SLAVE_CAN_STATE_UNKNOWN**	CAN State is unknown

Table 61: Flags of `ulCanState`

`aulUnused[2]`

This array has been introduced only for compatibility reasons. It is not used.

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ulFlags

This variable is organized as a bit field as described in the table below:

Bit	Name	Description
D32,,,D9	**-**	Unused
D8	**CANOPEN_SLAVE_STATE_FLAG_CAN_STARTED**	CAN network has been started
D7…D5	**-**	Unused
D4	**CANOPEN_SLAVE_STATE_FLAG_COMM_ERROR**	Communication Error
D3	**CANOPEN_SLAVE_STATE_FLAG_BUS_ON**	Bus on
D2	**CANOPEN_SLAVE_STATE_FLAG_COM**	Communication running
D1	**CANOPEN_SLAVE_STATE_FLAG_RUN**	Run
D0	**CANOPEN_SLAVE_STATE_FLAG_RDY**	Ready

Table 62: Bit field ulFlags

ulErrorCount

This field contains the total number of errors detected since power-up, respectively after reset. The protocol stack counts all sorts of errors in this field no matter if they were network related or caused internally.

ulCommError

This field contains the error code of the last communication error that occurred.

ulRunLedState

This field contains the current state of the RUN LED.

ulErrLedState

This field contains the current state of the ERR LED.

ulRecvDataCnt

This field contains the Received Data Count

ulSendDataCnt

This field contains the Send Data Count.

ulReserved

This field is reserved for future use.

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Extended Slave State Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_EXTENDED_STATE_Ttag</code> */
typedef struct CANOPEN_SLAVE_EXTENDED_STATE_Ttag
  CANOPEN_SLAVE_EXTENDED_STATE_T;

#define CANOPEN_SLAVE_EXT_STATE_FLAG_CAN_INIT     0x00000001L
#define CANOPEN_SLAVE_EXT_STATE_FLAG_CAN_ACTIVE   0x00000002L
#define CANOPEN_SLAVE_EXT_STATE_FLAG_PASSIVE      0x00000004L
#define CANOPEN_SLAVE_EXT_STATE_FLAG_BUS_OFF      0x00000008L

#define CANOPEN_SLAVE_EXT_STATE_FLAG_RX_OVERFLOW  0x00000010L
#define CANOPEN_SLAVE_EXT_STATE_FLAG_TX_OVERFLOW  0x00000020L
#define CANOPEN_SLAVE_EXT_STATE_FLAG_IND_LOST     0x00000040L

#define CANOPEN_SLAVE_EXT_STATE_FLAG_WDG          0x00000100L
#define CANOPEN_SLAVE_EXT_STATE_FLAG_SLAVE_ERROR  0x00000200L

#define CANOPEN_SLAVE_EXT_STATE_CTRL              0x00001000L
#define CANOPEN_SLAVE_EXT_STATE_NRDY              0x00002000L
#define CANOPEN_SLAVE_EXT_STATE_TIMEOUT           0x00004000L

#define CANOPEN_SLAVE_EXT_STATE_FLAG_WARNING      0x00010000L

#define CANOPEN_SLAVE_EXT_STATE_UNKNOWN           0x00000000L
#define CANOPEN_SLAVE_EXT_STATE_OPERATIONAL       0x00000001L
#define CANOPEN_SLAVE_EXT_STATE_STOP              0x00000002L
#define CANOPEN_SLAVE_EXT_STATE_PRE_OPERATIONAL   0x00000080L
#define CANOPEN_SLAVE_EXT_STATE_INITIALISING      0x000000FFL

#define CANOPEN_SLAVE_ADD_DETAIL_SIZE             0x00000003L

struct CANOPEN_SLAVE_EXTENDED_STATE_Ttag
{
  TLR_UINT32 ulFlags;
  TLR_UINT32 ulNodeState;
  TLR_UINT32 ulBusOffEveCnt;
  TLR_UINT32 ulErrorPassiveEveCnt;
  TLR_UINT32 ulRxOverflowCnt;
  TLR_UINT32 ulTxOverflowCnt;
  TLR_UINT32 ulErrorWarningCnt;
  TLR_UINT32 ulTimeoutCnt;

  TLR_UINT32 aulReserved[3];
  TLR_UINT32 ulIndLostCnt;

  TLR_UINT32 ulDiagInfoCount;
  TLR_UINT32 ulLastDiagInfo;
  TLR_UINT32 ulMaxRecvIdx;
  TLR_UINT32 ulMaxSendIdx;
  TLR_UINT32 aulAddDetail[CANOPEN_SLAVE_ADD_DETAIL_SIZE];

};

/*****************************************************************************/
```

The extended slave state is described in detail in section 3.3.2 “Extended Status”.

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Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_STATE_CHANGE_RES_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_STATE_CHANGE_RES_Ttag
  CANOPEN_SLAVE_PACKET_STATE_CHANGE_RES_T;

struct CANOPEN_SLAVE_PACKET_STATE_CHANGE_RES_Ttag
{
  TLR_PACKET_HEADER_T tHead;                    /** packet header.           */

};
/*****************************************************************************/
```

Packet Description

Structure Information CANOPEN_SLAVE_PACKET_STATE_CHANGE_RES_T				**Type: Response**
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	Structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle of CANopen slave-Task Process Queue
	ulSrc	UINT32		Source Queue-Handle of AP-Task Process Queue
	ulDestId	UINT32	ulCANOPENSLV0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process. Set to 0 for the Initialization Packet
	ulSrcId	UINT32	ulAPSS0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	0	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32		See section 6.2 *"Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x2913	CANOPEN_SLAVE_STATE_CHANGE_RES - Command
	ulExt	UINT32		Extension, reserved
	ulRout	UINT32		Routing Information, do not change

Table 63: CANOPEN_SLAVE_PACKET_STATE_CHANGE_RES_T – Change of State Response

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5.2.6 CANOPEN_SLAVE_SEND_EMCY_REQ/CNF – Send Emergency Message

This packet sends an emergency telegram to the CANopen network. The emergency error codes have the following meaning according to the CANopen specification:

Error Code	Meaning
00xx	Error reset or no error
10xx	Generic error
20xx	Current
21xx	Current, device input side
22xx	Current inside the device
23xx	Current, device output side
30xx	Voltage
31xx	Main voltage
32xx	Voltage inside the device
33xx	Output voltage
40xx	Temperature
41xx	Ambient temperature
42xx	Device temperature
50xx	Device hardware
60xx	Device software
61xx	Internal software
62xx	User software
63xx	Data set
70xx	Additional modules
80xx	Monitoring
81xx	Communication
8110	CAN overrun (objects lost)
8120	CAN in Error Passive Mode
8130	Life Guard Error or Heartbeat Error
8140	Recovered from bus-off
8150	Transmit COB-ID collision
82xx	Protocol error
8210	PDO not processed due to length error
8220	PDO length exceeded
90xx	External error
F0xx	Additional functions
FFxx	Device-specific

Table 64: Emergency Error Codes (Variable `usErrorCode`)

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The bits of the error register `bErrorRegister` have the following meaning:

Error	Code
CANOPEN_SLAVE_ERROR_REGISTER_GENERIC_BIT	0x01
CANOPEN_SLAVE_ERROR_REGISTER_CURRENT_BIT	0x02
CANOPEN_SLAVE_ERROR_REGISTER_VOLTAGE_BIT	0x04
CANOPEN_SLAVE_ERROR_REGISTER_TEMPERATURE_BIT	0x08
CANOPEN_SLAVE_ERROR_REGISTER_COMM_ERROR_BIT	0x10
CANOPEN_SLAVE_ERROR_REGISTER_DEV_PROFILE_BIT	0x20
CANOPEN_SLAVE_ERROR_REGISTER_RESERVED_BIT	0x40
CANOPEN_SLAVE_ERROR_REGISTER_MANU_SPEC_BIT	0x80

Table 65: Error Register

The field `abManErrorCode[5]` additionally provides the possibility to supply 5 bytes of manufacturer-specific error information.

Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_SEND_EMCY_REQ_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_SEND_EMCY_REQ_DATA_Ttag
  CANOPEN_SLAVE_SEND_EMCY_REQ_DATA_T;

#define CANOPEN_SLAVE_EMCY_DATA_SIZE 5

#define CANOPEN_SLAVE_ERROR_REGISTER_ERROR_RESET      0x00
#define CANOPEN_SLAVE_ERROR_REGISTER_GENERIC_BIT      0x01
#define CANOPEN_SLAVE_ERROR_REGISTER_CURRENT_BIT      0x02
#define CANOPEN_SLAVE_ERROR_REGISTER_VOLTAGE_BIT      0x04
#define CANOPEN_SLAVE_ERROR_REGISTER_TEMPERATURE_BIT  0x08
#define CANOPEN_SLAVE_ERROR_REGISTER_COMM_ERROR_BIT   0x10
#define CANOPEN_SLAVE_ERROR_REGISTER_DEV_PROFILE_BIT  0x20
#define CANOPEN_SLAVE_ERROR_REGISTER_RESERVED_BIT     0x40
#define CANOPEN_SLAVE_ERROR_REGISTER_MANU_SPEC_BIT    0x80

struct CANOPEN_SLAVE_SEND_EMCY_REQ_DATA_Ttag
{
  TLR_UINT16 usErrorCode;
  TLR_UINT8  abManErrorCode[CANOPEN_SLAVE_EMCY_DATA_SIZE];
  TLR_UINT8  bErrorRegister;
};

/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_SEND_EMCY_REQ_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_SEND_EMCY_REQ_Ttag
  CANOPEN_SLAVE_PACKET_SEND_EMCY_REQ_T;

struct CANOPEN_SLAVE_PACKET_SEND_EMCY_REQ_Ttag
{
  TLR_PACKET_HEADER_T                 tHead; /** packet header.            */
  CANOPEN_SLAVE_SEND_EMCY_REQ_DATA_T  tData; /** packet request data.      */
};
/*****************************************************************************/
```


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Packet Description

Structure Information CANOPEN_SLAVE_PACKET_SEND_EMCY_REQ_T				Type: Request
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	Structure TLR_PACKET_HEADER_T			
	ulDest	UINT32	0x20/ QUE_CANOPEN SLV	Destination Queue-Handle of CANopen slave-Task Process Queue
	ulSrc	UINT32	0 ... 2^{32}-1	Source Queue-Handle of AP-Task Process Queue
	ulDestId	UINT32	ulCANOPENSL V0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process
	ulSrcId	UINT32	ulAPSS0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	8	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32	0	See section 6.2 *"Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x2918	CANOPEN_SLAVE_SEND_EMCY_REQ - Command
	ulExt	UINT32	0	Reserved
	ulRout	UINT32	x	Routing Information
tData	Structure CANOPEN_SLAVE_SEND_EMCY_REQ_DATA_T			
	usErrorCode	UINT16		Emergency Error Code
	abManError Code[5]	UINT8[]		Area for manufacturer-specific error codes
	bErrorRegist er	UINT8	Bit mask	*See Table 65: Error Register*

Table 66: CANOPEN_SLAVE_PACKET_SEND_EMCY_REQ_T – Send Emergency Message Request

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Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_SEND_EMCY_CNF_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_SEND_EMCY_CNF_Ttag
  CANOPEN_SLAVE_PACKET_SEND_EMCY_CNF_T;

struct CANOPEN_SLAVE_PACKET_SEND_EMCY_CNF_Ttag
{
  TLR_PACKET_HEADER_T tHead;                /** packet header.           */
};
/*****************************************************************************/
```

Packet Description

Structure Information CANOPEN_SLAVE_PACKET_SEND_EMCY_CNF_T				**Type: Confirmation**
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	Structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle, untouched
	ulSrc	UINT32		Source Queue-Handle, untouched
	ulDestId	UINT32	ulAPSS0Id	Destination End Point Identifier, untouched
	ulSrcId	UINT32	ulCANOPENSLV0Id	Source End Point Identifier, untouched
	ulLen	UINT32	0	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32		See section 6.2 *"Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x2919	CANOPEN_SALVE_SEND_EMCY_CNF - Command
	ulExt	UINT32		Extension, reserved
	ulRout	UINT32		Routing Information, do not change

Table 67: CANOPEN_SLAVE_PACKET_SEND_EMCY_CNF_T – Send Emergency Message Confirmation

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5.2.7 CANOPEN_SLAVE_SEND_EMCY_IND/RES – Emergency Message Indication

This indication informs the application about the sending of an emergency telegram by the CANopen protocol stack. The emergency error codes have the following meaning:

Error Code	Meaning
00xx	Error reset or no error
10xx	Generic error
20xx	Current
21xx	Current, device input side
22xx	Current inside the device
23xx	Current, device output side
30xx	Voltage
31xx	Main voltage
32xx	Voltage inside the device
33xx	Output voltage
40xx	Temperature
41xx	Ambient temperature
42xx	Device temperature
50xx	Device hardware
60xx	Device software
61xx	Internal software
62xx	User software
63xx	Data set
70xx	Additional modules
80xx	Monitoring
81xx	Communication
8110	CAN overrun (objects lost)
8120	CAN in Error Passive Mode
8130	Life Guard Error or Heartbeat Error
8140	Recovered from bus-off
8150	Transmit COB-ID collision
82xx	Protocol error
8210	PDO not processed due to length error
8220	PDO length exceeded
90xx	External error
F0xx	Additional functions
FFxx	Device-specific

Table 68: Emergency Error Codes (Variable `usErrorCode`)

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The bits of the error register bErrorRegister have the following meaning:

Error	Code
CANOPEN_SLAVE_ERROR_REGISTER_GENERIC_BIT	0x01
CANOPEN_SLAVE_ERROR_REGISTER_CURRENT_BIT	0x02
CANOPEN_SLAVE_ERROR_REGISTER_VOLTAGE_BIT	0x04
CANOPEN_SLAVE_ERROR_REGISTER_TEMPERATURE_BIT	0x08
CANOPEN_SLAVE_ERROR_REGISTER_COMM_ERROR_BIT	0x10
CANOPEN_SLAVE_ERROR_REGISTER_DEV_PROFILE_BIT	0x20
CANOPEN_SLAVE_ERROR_REGISTER_RESERVED_BIT	0x40
CANOPEN_SLAVE_ERROR_REGISTER_MANU_SPEC_BIT	0x80

Table 69: Error Register

The field abManErrorCode[5] additionally provides the possibility to supply 5 bytes of manufacturer-specific error information.

Packet Structure Reference

```
/** type of <code>CANOPEN_SLAVE_SEND_EMCY_IND_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_SEND_EMCY_IND_DATA_Ttag
  CANOPEN_SLAVE_SEND_EMCY_IND_DATA_T;

struct CANOPEN_SLAVE_SEND_EMCY_IND_DATA_Ttag
{
  TLR_UINT16 usErrorCode;
  TLR_UINT8  abManErrorCode[CANOPEN_SLAVE_EMCY_DATA_SIZE];
  TLR_UINT8  bErrorRegister;
};

/** type of <code>CANOPEN_SLAVE_PACKET_SEND_EMCY_IND_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_SEND_EMCY_IND_Ttag
  CANOPEN_SLAVE_PACKET_SEND_EMCY_IND_T;

struct CANOPEN_SLAVE_PACKET_SEND_EMCY_IND_Ttag
{
  TLR_PACKET_HEADER_T                 tHead; /** packet header.            */
  CANOPEN_SLAVE_SEND_EMCY_IND_DATA_T  tData; /** packet induest data.      */
};
```


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Packet Description

Structure Information CANOPEN_SLAVE_PACKET_SEND_EMCY_IND_T				Type: Indication
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	Structure TLR_PACKET_HEADER_T			
	ulDest	UINT32	QUE_CANOPENSLV	Destination Queue-Handle of CANopen slave-Task Process Queue
	ulSrc	UINT32	0 ... 2^{32}-1	Source Queue-Handle of AP-Task Process Queue
	ulDestId	UINT32	ulAPSS0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process
	ulSrcId	UINT32	ulCANOPENSLV0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	8	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32	0	See section 6.2 *"Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x2938	CANOPEN_SLAVE_SEND_EMCY_IND - Command
	ulExt	UINT32	0	Reserved
	ulRout	UINT32	x	Routing Information
tData	Structure CANOPEN_SLAVE_SEND_EMCY_IND_DATA_T			
	usErrorCode	UINT16		Emergency Error Code, see *Table 68: Emergency Error Codes (Variable usErrorCode)*
	abManErrorCode[5]	UINT8[]		Area for manufacturer-specific error codes
	bErrorRegister	UINT8	Bit mask	*See Table 69: Error Register*

Table 70: CANOPEN_SLAVE_PACKET_SEND_EMCY_IND_T – Send Emergency Message Indication

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Packet Structure Reference

```
/** type of <code>CANOPEN_SLAVE_PACKET_SEND_EMCY_RES_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_SEND_EMCY_RES_Ttag
  CANOPEN_SLAVE_PACKET_SEND_EMCY_RES_T;

struct CANOPEN_SLAVE_PACKET_SEND_EMCY_RES_Ttag
{
  TLR_PACKET_HEADER_T tHead;                /** packet header.           */
};
```

Packet Description

Structure Information CANOPEN_SLAVE_PACKET_SEND_EMCY_RES_T				**Type: Response**
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	Structure TLR_PACKET_HEADER_T			
	ulDest	UINT32	QUE_CANOPENSLV	Destination Queue-Handle of CANopen slave-Task Process Queue
	ulSrc	UINT32	0 ... 2^{32}-1	Source Queue-Handle of AP-Task Process Queue
	ulDestId	UINT32	ulCANOPENSLV0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process
	ulSrcId	UINT32	ulAPSS0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	8	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32	0	See section 6.2 *"Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x2939	CANOPEN_SLAVE_SEND_EMCY_RES - Command
	ulExt	UINT32	0	Reserved
	ulRout	UINT32	x	Routing Information

Table 71: CANOPEN_SLAVE_PACKET_SEND_EMCY_RES_T – Response to Send Emergency Message Indication

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5.2.8 CANOPEN_SLAVE_SET_NMT_STATE_REQ/CNF – Set NMT State

This packet allows the host application to set the NMT state of the CANopen slave.

Normally the state is set by the NMT Master using the CANOPEN_SLAVE_NMT_COMMAND_IND indication, but sometimes it may be necessary to control the state manually from the host application.

Which state is set depends on the value of the variable `ulNmtState`, which may have the values described in the following table:

Value	Symbolic Name	Meaning
1	CANOPEN_SLAVE_SET_NMT_STATE_OPERATIONAL	Operational
2	CANOPEN_SLAVE_SET_NMT_STATE_STOP	Stop
128	CANOPEN_SLAVE_SET_NMT_STATE_PRE_OPERATIONAL	Pre-operational
129	CANOPEN_SLAVE_SET_NMT_STATE_RESET_NODE	Reset node
130	CANOPEN_SLAVE_SET_NMT_STATE_RESET_COMM	Reset communication

Table 72: NMT States

The value 1 for Operational is only supported for compatibility reasons. However, according to the CANopen specification, only the NMT Master is allowed to set the NMT state to *Operational*.

Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_SET_NMT_STATE_REQ_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_SET_NMT_STATE_REQ_DATA_Ttag
  CANOPEN_SLAVE_SET_NMT_STATE_REQ_DATA_T;

#define CANOPEN_SLAVE_SET_NMT_STATE_OPERATIONAL       0x00000001L
#define CANOPEN_SLAVE_SET_NMT_STATE_STOP              0x00000002L
#define CANOPEN_SLAVE_SET_NMT_STATE_PRE_OPERATIONAL   0x00000080L
#define CANOPEN_SLAVE_SET_NMT_STATE_RESET_NODE        0x00000081L
#define CANOPEN_SLAVE_SET_NMT_STATE_RESET_COMM        0x00000082L

struct CANOPEN_SLAVE_SET_NMT_STATE_REQ_DATA_Ttag
{
  TLR_UINT32 ulNmtState;  /* NMT state */
};

/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_SET_NMT_STATE_REQ_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_SET_NMT_STATE_REQ_Ttag
  CANOPEN_SLAVE_PACKET_SET_NMT_STATE_REQ_T;

struct CANOPEN_SLAVE_PACKET_SET_NMT_STATE_REQ_Ttag
{
  TLR_PACKET_HEADER_T                    tHead; /** packet header.            */
  CANOPEN_SLAVE_SET_NMT_STATE_REQ_DATA_T tData; /** packet data.              */
};

/*****************************************************************************/
```


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Packet Description

Structure Information CANOPEN_SLAVE_PACKET_SET_NMT_STATE_REQ_T				Type: Request
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	Structure TLR_PACKET_HEADER_T			
	ulDest	UINT32	0x20/ QUE_CANOPEN SLV	Destination Queue-Handle of CANopen slave-Task Process Queue
	ulSrc	UINT32	0 ... 2^{32}-1	Source Queue-Handle of AP-Task Process Queue
	ulDestId	UINT32	ulCANOPENSL V0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process
	ulSrcId	UINT32	ulAPSS0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	4	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32	0	See section 6.2 *"Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x0000291A	*CANOPEN_SLAVE_SET_NMT_STATE_REQ* - Command
	ulExt	UINT32	0	Reserved
	ulRout	UINT32	x	Routing Information
tData	Structure CANOPEN_SLAVE_NODE_NMT_COMMAND_REQ_DATA_T			
	ulNmtState	UINT32	1,2,128..130	State requested to be set *See Table 72: NMT States*

Table 73: CANOPEN_SLAVE_PACKET_SET_NMT_STATE_REQ_T – Set NMT State Request

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Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_SET_NMT_STATE_CNF_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_SET_NMT_STATE_CNF_DATA_Ttag
  CANOPEN_SLAVE_SET_NMT_STATE_CNF_DATA_T;

struct CANOPEN_SLAVE_SET_NMT_STATE_CNF_DATA_Ttag
{
  TLR_UINT32 ulNmtState; /* NMT state */
};
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_SET_NMT_STATE_CNF_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_SET_NMT_STATE_CNF_Ttag
  CANOPEN_SLAVE_PACKET_SET_NMT_STATE_CNF_T;

struct CANOPEN_SLAVE_PACKET_SET_NMT_STATE_CNF_Ttag
{
  TLR_PACKET_HEADER_T tHead;                    /** packet header.            */
  CANOPEN_SLAVE_SET_NMT_STATE_CNF_DATA_T tData; /** packet data.              */
};
/*****************************************************************************/
```

Packet Description

Structure Information CANOPEN_SLAVE_PACKET_SET_NMT_STATE_CNF_T				**Type: Confirmation**
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	Structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle, untouched
	ulSrc	UINT32		Source Queue-Handle, untouched
	ulDestId	UINT32	ulAPSS0Id	Destination End Point Identifier, untouched
	ulSrcId	UINT32	ulCANOPENSLV0Id	Source End Point Identifier, untouched
	ulLen	UINT32	4	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32		See section 6.2 *"Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x0000291B	CANOPEN_SLAVE_SET_NMT_STATE_CNF - Command
	ulExt	UINT32		Extension, reserved
	ulRout	UINT32		Routing Information, do not change
tData	Structure CANOPEN_SLAVE_NODE_NMT_COMMAND_REQ_DATA_T			
	ulNmtState	UINT32	1,2,128..130	NMT State having really been set *See Table 72: NMT States*

Table 74: CANOPEN_SLAVE_PACKET_SET_NMT_STATE_CNF_T – Set NMT State Confirmation

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5.2.9 CANOPEN_SLAVE_SET_BUSPARAM_REQ/CNF – Set Bus Parameters

This packet can be applied for setting the bus parameters for the CANopen Slave.

Note: Use this packet only when working with linkable object modules. It is not designed for usage in the context of loadable firmware. In the context of loadable firmware we recommend to use ‘set configuration’ instead.

Note: This request will be denied if the configuration lock flag is set.

All parameters used by this packet are also used by the packet CANOPEN_APS_SET_CONFIGURATION_REQ/CNF – Set Configuration with the same meaning and in the same way. For more information about these parameters,, see *Table 45: Bus parameter structure CANOPEN_SLAVE_BUSPARAM_DATA_T* on page 78. and the description given there.

Packet Structure Reference

```
/*****************************************************************************
***/
/** type of <code>CANOPEN_SLAVE_STD_BUSPARAM_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_STD_BUSPARAM_DATA_Ttag
  CANOPEN_SLAVE_STD_BUSPARAM_DATA_T;
/** type of <code>CANOPEN_SLAVE_EXT_BUSPARAM_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_EXT_BUSPARAM_DATA_Ttag
  CANOPEN_SLAVE_EXT_BUSPARAM_DATA_T;
/** type of <code>CANOPEN_SLAVE_BUSPARAM_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_BUSPARAM_DATA_Ttag
  CANOPEN_SLAVE_BUSPARAM_DATA_T;

/*------ Common configuration flags ---------------------------------------*/
#define CANOPEN_SLAVE_COMMON_FLAG_CFG_EXT_MODE                  0x10000000L
#define CANOPEN_SLAVE_COMMON_FLAG_CFG_HOLD_LAST_STATE           0x01000000L
#define CANOPEN_SLAVE_COMMON_FLAG_CFG_DISABLE_SEND_COS_SYNC_ACYC 0x00010000L
#define CANOPEN_SLAVE_COMMON_FLAG_CFG_DISABLE_SEND_COS_MAN_SPEC  0x00020000L
#define CANOPEN_SLAVE_COMMON_FLAG_CFG_DISABLE_SEND_COS_PROF_SPEC 0x00040000L
/*-----------------------------------------------------------------------*/

/*------ Configuration flags and for standard mode only -------------------*/
#define CANOPEN_SLAVE_STD_FLAG_CFG_VENDOR_ID                     0x00000010L
#define CANOPEN_SLAVE_STD_FLAG_CFG_PRODUCT_CODE                  0x00000020L
#define CANOPEN_SLAVE_STD_FLAG_CFG_SERIAL_NUMBER                 0x00000040L
#define CANOPEN_SLAVE_STD_FLAG_CFG_REVISION_NUMBER               0x00000080L
#define CANOPEN_SLAVE_STD_FLAG_CFG_DEVICE_TYPE                   0x00000100L
#define CANOPEN_SLAVE_STD_FLAG_CFG_OBJECT_SIZE                   0x00000200L
#define CANOPEN_SLAVE_STD_FLAG_CFG_PDO_CNT                       0x00000400L
/*-----------------------------------------------------------------------*/

/*------ Configuration flags for extended mode only -----------------------*/

/*-----------------------------------------------------------------------*/

#define CANOPEN_SLAVE_MIN_SLAVE_NODE_ID        1            /* Minimum node ID
*/
#define CANOPEN_SLAVE_MAX_SLAVE_NODE_ID        127          /* Maximum node ID
*/

#define CANOPEN_SLAVE_CFG_BAUD_1000            0x00000000L  /* 1MBaud          */
#define CANOPEN_SLAVE_CFG_BAUD_800             0x00000001L  /* 800kBaud        */
#define CANOPEN_SLAVE_CFG_BAUD_500             0x00000002L  /* 500kBaud        */
```


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```
#define CANOPEN_SLAVE_CFG_BAUD_250             0x00000003L   /* 250kBaud         */
#define CANOPEN_SLAVE_CFG_BAUD_125             0x00000004L   /* 125kBaud         */
#define CANOPEN_SLAVE_CFG_BAUD_100             0x00000005L   /* 100kBaud         */
#define CANOPEN_SLAVE_CFG_BAUD_50              0x00000006L   /* 50kBaud          */
#define CANOPEN_SLAVE_CFG_BAUD_20              0x00000007L   /* 20kBaud          */
#define CANOPEN_SLAVE_CFG_BAUD_10              0x00000008L   /* 10kBaud          */
#define CANOPEN_SLAVE_CFG_BAUD_AUTO_DETECTION  0x000000FFL   /* Auto-Baud detection
*/

#define CANOPEN_SLAVE_STD_CFG_DEF_OBJECT_SIZE  128 /* Default object size in std
mode */

#define CANOPEN_SLAVE_CFG_MAX_RXPDO            256 /* Maximum number of RxPDO    */
#define CANOPEN_SLAVE_CFG_MAX_TXPDO            256 /* Maximum number of TxPDO    */

__PACKED_PRE struct CANOPEN_SLAVE_STD_BUSPARAM_DATA_Ttag
{
  TLR_UINT32 ulVendorId;       /* Vendor ID              */
  TLR_UINT32 ulProductCode;    /* Product code           */
  TLR_UINT32 ulSerialNumber;   /* Serial number          */
  TLR_UINT32 ulRevisionNumber; /* Revision number        */
  TLR_UINT32 ulDeviceType;     /* Device Type            */

  TLR_UINT8  bObject2000Size;  /* Size of object 2000    */
  TLR_UINT8  bObject2001Size;  /* Size of object 2001    */
  TLR_UINT8  bObject2002Size;  /* Size of object 2002    */
  TLR_UINT8  bObject2003Size;  /* Size of object 2003    */

  TLR_UINT8  bObject2200Size;  /* Size of object 2200    */
  TLR_UINT8  bObject2201Size;  /* Size of object 2201    */
  TLR_UINT8  bObject2202Size;  /* Size of object 2202    */
  TLR_UINT8  bObject2203Size;  /* Size of object 2203    */

  TLR_UINT16 usNumOfRxPdo;     /* Number of receive PDOs  */
  TLR_UINT16 usNumOfTxPdo;     /* Number of transmit PDOs */

  TLR_UINT32 aulReserved[2];   /* Reserved, set to zero   */

}__PACKED_POST;

__PACKED_PRE struct CANOPEN_SLAVE_EXT_BUSPARAM_DATA_Ttag
{
  TLR_UINT16 usNumOfRxPdo;     /* Number of receive PDOs  */
  TLR_UINT16 usNumOfTxPdo;     /* Number of transmit PDOs */
  TLR_UINT32 aulReserved[9];   /* Reserved, set to zero   */

}__PACKED_POST;

/** Structure of task command set bus param data */
__PACKED_PRE struct CANOPEN_SLAVE_BUSPARAM_DATA_Ttag
{
  TLR_UINT32 ulSlaveNodeId;  /* Node ID       */
  TLR_UINT32 ulBaudrate;     /* Baud-rate     */
  TLR_UINT32 ulCanOpenFlags; /* CANopen flags */

  __PACKED_PRE union
  {
    CANOPEN_SLAVE_STD_BUSPARAM_DATA_T tStdBusParam; /* Parameter for standard
mode*/
    CANOPEN_SLAVE_EXT_BUSPARAM_DATA_T tExtBusParam; /* Parameter for extended
mode*/

  }__PACKED_POST uMode;

  TLR_UINT32 ul29BitCode; /* 29Bit Code */
  TLR_UINT32 ul29BitMask; /* 29Bit Mask */

}__PACKED_POST;
```


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```
/*****************************************************************************
***/
/** type of <code>CANOPEN_SLAVE_BUSPARAM_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_BUSPARAM_DATA_Ttag
  CANOPEN_SLAVE_SET_BUSPARAM_REQ_DATA_T;

/*****************************************************************************
***/
/** type of <code>CANOPEN_SLAVE_BUSPARAM_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_BUSPARAM_DATA_Ttag
  CANOPEN_SLAVE_GET_BUSPARAM_CNF_DATA_T;

/*****************************************************************************/
```


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Packet Description

Structure Information CANOPEN_SLAVE_PACKET_SET_BUSPARAM_REQ_T				Type: Request
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	Structure TLR_PACKET_HEADER_T			
	ulDest	UINT32	QUE_CANOPENSLV	Destination Queue-Handle of CANopen slave-Task Process Queue
	ulSrc	UINT32	0 ... 2^{32}-1	Source Queue-Handle of AP-Task Process Queue
	ulDestId	UINT32	ulCANOPENSLV0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process
	ulSrcId	UINT32	ulAPSS0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	80	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32	0	See section 6.2 *"Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x2906	*CANOPEN_SLAVE_SET_BUSPARAM_REQ* - Command
	ulExt	UINT32	0	Reserved
	ulRout	UINT32	x	Routing Information
tData	Structure CANOPEN_SLAVE_SET_BUSPARAM_REQ_DATA_T			
	tBusParam	CANOPEN_SLAVE_BUSPARAM_DATA_T		Bus parameter structure, see *Table 45: Bus parameter structure CANOPEN_SLAVE_BUSPARAM_DATA_T*

Table 75: CANOPEN_SLAVE_PACKET_SET_BUSPARAM_REQ_T – Set Bus Parameters Request

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Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_SET_BUSPARAM_CNF_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_SET_BUSPARAM_CNF_Ttag
  CANOPEN_SLAVE_PACKET_SET_BUSPARAM_CNF_T;

/** Structure of task command set bus parameter confirmation */
struct CANOPEN_SLAVE_PACKET_SET_BUSPARAM_CNF_Ttag
{
  TLR_PACKET_HEADER_T tHead;                    /** packet header.       */
};
/*****************************************************************************/
```

Packet Description

Structure Information CANOPEN_SLAVE_PACKET_SET_BUSPARAM_CNF_T				**Type: Confirmation**
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	Structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle, untouched
	ulSrc	UINT32		Source Queue-Handle, untouched
	ulDestId	UINT32	ulAPSS0Id	Destination End Point Identifier, untouched
	ulSrcId	UINT32	ulCANOPENSLV0Id	Source End Point Identifier, untouched
	ulLen	UINT32	0	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32		See section 6.2 *Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x2907	CANOPEN_SLAVE_SET_BUSPARAM_CNF - Command
	ulExt	UINT32		Extension, reserved
	ulRout	UINT32		Routing Information, do not change

Table 76: CANOPEN_SLAVE_PACKET_SET_BUSPARAM_CNF_T –Set Bus Parameter Confirmation

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5.2.10 CANOPEN_SLAVE_SEND_TIME_STAMP_REQ/CNF – Send Time Stamp

This packet allows to send a time stamp according to the CANopen time stamp protocol, if the CANopen Slave is a valid time stamp producer.

See *Figure 15: CANopen Time Stamp Protocol* below:

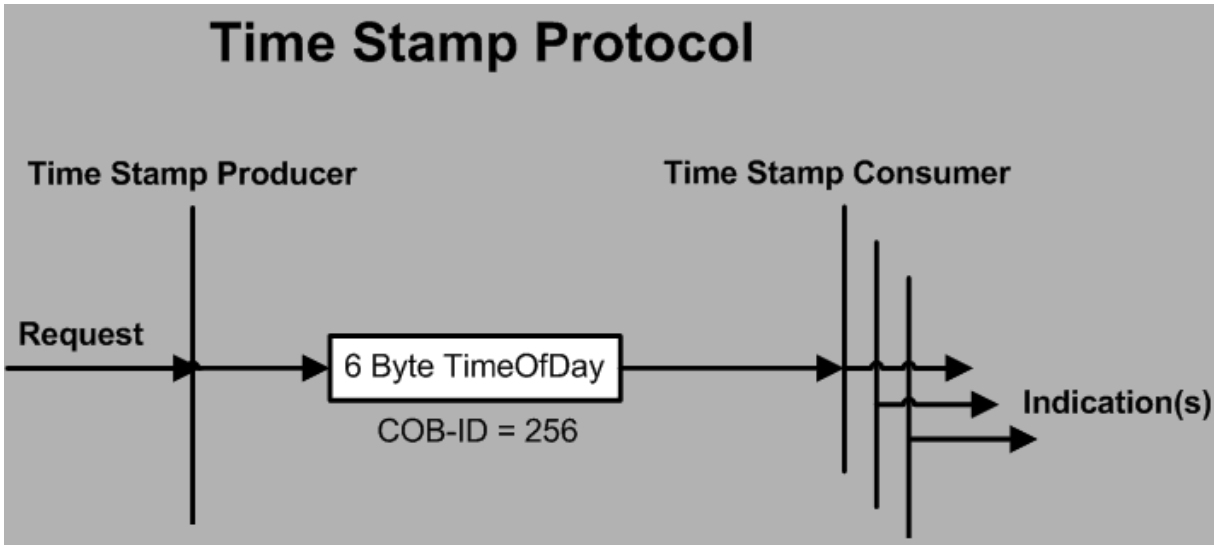

Figure 15: CANopen Time Stamp Protocol

The contents of the time stamp is divided into a milliseconds part and a days part:

- The milliseconds part (variable `ulMilliseconds`) contains the number of milliseconds that have occurred since midnight.
- The days part (variable `usDays`) contains the number of days that have occurred since January 1, 1984.

Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_SEND_TIME_STAMP_REQ_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_SEND_TIME_STAMP_REQ_DATA_Ttag
  CANOPEN_SLAVE_SEND_TIME_STAMP_REQ_DATA_T;

struct CANOPEN_SLAVE_SEND_TIME_STAMP_REQ_DATA_Ttag
{
  TLR_UINT32 ulMilliseconds;
  TLR_UINT16 usDays;
};

/*****************************************************************************/

/** type of <code>CANOPEN_SLAVE_PACKET_SEND_TIME_STAMP_REQ_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_SEND_TIME_STAMP_REQ_Ttag
  CANOPEN_SLAVE_PACKET_SEND_TIME_STAMP_REQ_T;

 struct CANOPEN_SLAVE_PACKET_SEND_TIME_STAMP_REQ_Ttag
{
  TLR_PACKET_HEADER_T                     tHead; /** packet header.            */
  CANOPEN_SLAVE_SEND_TIME_STAMP_REQ_DATA_T  tData; /** packet request data.      */
};

/*****************************************************************************/
```


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Packet Description

structure CANOPEN_SLAVE_PACKET_SEND_TIME_STAMP_REQ_T				Type: Request
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	structure TLR_PACKET_HEADER_T			
	ulDest	UINT32	0x20/ QUE_CANOPEN SLV	Destination Queue-Handle
	ulSrc	UINT32	0 ... 2^{32}-1	Source Queue-Handle
	ulDestId	UINT32	ulCANOPENSL V0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process. Set to 0 for the Initialization Packet
	ulSrcId	UINT32	ulAPSS0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	6	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32	0	See section 6.2 *Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x291E	CANOPEN_SLAVE_SEND_TIME_STAMP_REQ - Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch
tData	structure CANOPEN_SLAVE_SEND_TIME_STAMP_REQ_DATA_T			
	ulMilliseconds	UINT32	0 ... 86.399.999	Milliseconds part of time stamp (number of milliseconds that have occurred since last midnight)
	usDays	UINT16	0..65535	Days part of time stamp (number of days that have occurred since January 1, 1984)

Table 77: CANOPEN_SLAVE_PACKET_SEND_TIME_STAMP_REQ_T - Send Time Stamp Request

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Packet Structure Reference

```
/*****************************************************************************/

/** type of <code>CANOPEN_SLAVE_PACKET_SEND_TIME_STAMP_CNF_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_SEND_TIME_STAMP_CNF_Ttag
  CANOPEN_SLAVE_PACKET_SEND_TIME_STAMP_CNF_T;

 struct CANOPEN_SLAVE_PACKET_SEND_TIME_STAMP_CNF_Ttag
{
  TLR_PACKET_HEADER_T tHead;                        /** packet header. */

};
/*****************************************************************************/
```

Packet Description

structure CANOPEN_SLAVE_PACKET_SEND_TIME_STAMP_CNF_T				**Type: Confirmation**
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle
	ulSrc	UINT32		Source Queue-Handle
	ulDestId	UINT32	ulAPSS0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process. Set to 0 for the Initialization Packet
	ulSrcId	UINT32	ulCANOPENSLV0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	0	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32		See section 6.2 *Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x291F	CANOPEN_SLAVE_SEND_TIME_STAMP_CNF - Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch

Table 78: CANOPEN_SLAVE_PACKET_SEND_TIME_STAMP_CNF_T – Confirmation to Send Time Stamp Request

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5.2.11 CANOPEN_SLAVE_RECV_TIME_STAMP_IND/RES – Receive Time Stamp Indication

This indication packet is received when the Time Stamp Producer sends a time stamp by issueing a time service (TIME). The time service and the time protocol are described in section 9.2.4 of CANopen document DR301. Also, see *Figure 15: CANopen Time Stamp Protocol* in the preceding subsection:

The contents of the time stamp is divided into a milliseconds part and a days part:

- The milliseconds part (variable `ulMilliseconds`) contains the number of milliseconds that have occurred since midnight.
- The days part (variable `usDays`) contains the number of days that have occurred since January 1, 1984.

Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_RECV_TIME_STAMP_IND_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_RECV_TIME_STAMP_IND_DATA_Ttag
  CANOPEN_SLAVE_RECV_TIME_STAMP_IND_DATA_T;

 struct CANOPEN_SLAVE_RECV_TIME_STAMP_IND_DATA_Ttag
{
  TLR_UINT32 ulMilliseconds;
  TLR_UINT16 usDays;
};

/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_RECV_TIME_STAMP_IND_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_RECV_TIME_STAMP_IND_Ttag
  CANOPEN_SLAVE_PACKET_RECV_TIME_STAMP_IND_T;

 struct CANOPEN_SLAVE_PACKET_RECV_TIME_STAMP_IND_Ttag
{
  TLR_PACKET_HEADER_T                      tHead; /** packet header.            */
  CANOPEN_SLAVE_RECV_TIME_STAMP_IND_DATA_T  tData; /** packet request data.      */
};
/*****************************************************************************/
```


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Packet Description

structure CANOPEN_SLAVE_PACKET_RECV_TIME_STAMP_IND_T				Type: Indication
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle
	ulSrc	UINT32		Source Queue-Handle
	ulDestId	UINT32	ulAPSS0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process. Set to 0 for the Initialization Packet
	ulSrcId	UINT32	ulCANOPENSLV0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	6	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32		See section 6.2 *Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x2920	CANOPEN_SLAVE_RECV_TIME_STAMP_IND - Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch
tData	structure CANOPEN_SLAVE_RECV_TIME_STAMP_IND_DATA_T			
	ulMilliseconds	UINT32	0 ... 86.399.999	Milliseconds part of time stamp (number of milliseconds that have occurred since last midnight)
	usDays	UINT16	0..65535	Days part of time stamp (number of days that have occurred since January 1, 1984)

Table 79: CANOPEN_SLAVE_PACKET_RECV_TIME_STAMP_IND_T - Receive Time Stamp Indication

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Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_RECV_TIME_STAMP_RES_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_RECV_TIME_STAMP_RES_Ttag
  CANOPEN_SLAVE_PACKET_RECV_TIME_STAMP_RES_T;

struct CANOPEN_SLAVE_PACKET_RECV_TIME_STAMP_RES_Ttag
{
  TLR_PACKET_HEADER_T tHead;                    /** packet header.            */

};
/*****************************************************************************/
```

Packet Description

structure CANOPEN_SLAVE_PACKET_RECV_TIME_STAMP_RES_T				**Type: Response**
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle
	ulSrc	UINT32		Source Queue-Handle
	ulDestId	UINT32	ulCANOPENSLV0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process. Set to 0 for the Initialization Packet
	ulSrcId	UINT32	ulAPSS0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	0	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32		See section 6.2 *Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x2921	CANOPEN_SLAVE_RECV_TIME_STAMP_RES - Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch

Table 80: CANOPEN_SLAVE_PACKET_RECV_TIME_STAMP_RES- Response to Receive Time Stamp Indication

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5.2.12 CANOPEN_SLAVE_SEND_TXPDO_REQ – Send TxPDO Request

This packet allows to send one or more TxPDOs to a communication partner (CANopen Master or Slave) on the CANopen network using the Write PDO.Protocol, see upper part of *Figure 16: CANopen PDO.Protocol*

.

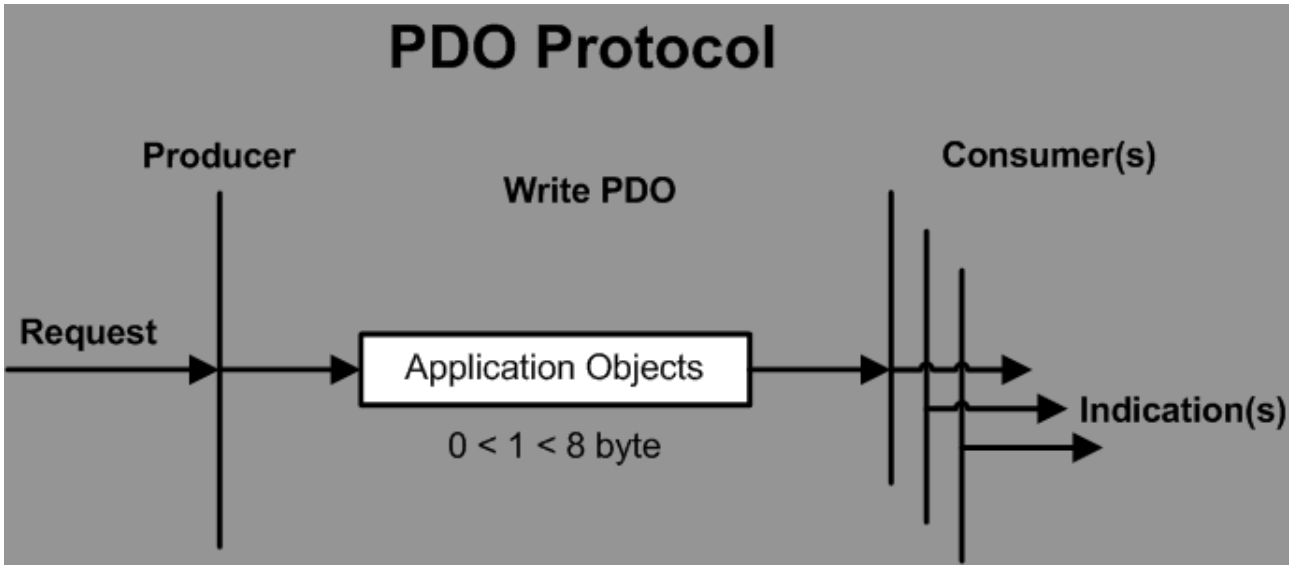

Figure 16: CANopen PDO.Protocol

This can be done simultaneously for up to 16 TxPDOs, whose numbers must be assigned to the members of array `aulRecvRxPdoNumber[]` of the request packet.

The 16 TxPDOs will be processed separately and for each the resulting status code (success/error) will be stored in array `aulRecvRxPdoResult[]` of the confirmation packet

Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_SEND_TXPDO_REQ_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_SEND_TXPDO_REQ_DATA_Ttag
  CANOPEN_SLAVE_SEND_TXPDO_REQ_DATA_T;

#define CANOPEN_SLAVE_SEND_TXPDO_REQ_MAX    16

 struct CANOPEN_SLAVE_SEND_TXPDO_REQ_DATA_Ttag
{
  TLR_UINT32 aulSendTxPdoNumber[CANOPEN_SLAVE_SEND_TXPDO_REQ_MAX];
};

/** type of <code>CANOPEN_SLAVE_PACKET_SEND_TXPDO_REQ_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_SEND_TXPDO_REQ_Ttag
  CANOPEN_SLAVE_PACKET_SEND_TXPDO_REQ_T;

 struct CANOPEN_SLAVE_PACKET_SEND_TXPDO_REQ_Ttag
{
  TLR_PACKET_HEADER_T                 tHead; /** packet header. */
  CANOPEN_SLAVE_SEND_TXPDO_REQ_DATA_T tData; /** packet data.   */
};

/*****************************************************************************/
```


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Packet Description

structure CANOPEN_SLAVE_PACKET_SEND_TXPDO_REQ_T				Type: Request
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	structure TLR_PACKET_HEADER_T			
	ulDest	UINT32	0x20/ QUE_CANOPEN SLV	Destination Queue-Handle
	ulSrc	UINT32	0 ... 2^{32}-1	Source Queue-Handle
	ulDestId	UINT32	ulCANOPENSL V0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process. Set to 0 for the Initialization Packet
	ulSrcId	UINT32	ulAPSS0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	64	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32	0	See section 6.2 *Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x2922	CANOPEN_SLAVE_SEND_TXPDO_REQ - Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch
tData	structure CANOPEN_SLAVE_SEND_TXPDO_REQ_DATA_T			
	aulSendTxPdoNu mber[]	UINT32[16]	1..255 for each number	Array of numbers of TxPDOs for sending

Table 81: CANOPEN_SLAVE_PACKET_SEND_TXPDO_REQ_T – Send TxPDO Request

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Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_SEND_TXPDO_CNF_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_SEND_TXPDO_CNF_DATA_Ttag
  CANOPEN_SLAVE_SEND_TXPDO_CNF_DATA_T;

#define CANOPEN_SLAVE_SEND_TXPDO_REQ_MAX    16

 struct CANOPEN_SLAVE_SEND_TXPDO_CNF_DATA_Ttag
{
  TLR_UINT32 aulSendTxPdoResult[CANOPEN_SLAVE_SEND_TXPDO_REQ_MAX];
};

/** type of <code>CANOPEN_SLAVE_PACKET_SEND_TXPDO_CNF_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_SEND_TXPDO_CNF_Ttag
  CANOPEN_SLAVE_PACKET_SEND_TXPDO_CNF_T;

 struct CANOPEN_SLAVE_PACKET_SEND_TXPDO_CNF_Ttag
{
  TLR_PACKET_HEADER_T                 tHead; /** packet header. */
  CANOPEN_SLAVE_SEND_TXPDO_CNF_DATA_T tData; /** packet data.   */
};
/*****************************************************************************/
```

Packet Description

structure **CANOPEN_SLAVE_PACKET_SEND_TXPDO_CNF_T**				**Type: Confirmation**
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle
	ulSrc	UINT32		Source Queue-Handle
	ulDestId	UINT32	ulAPSS0Id	Destination End Point Identifier, specifying the final receiver of packet within the Destination Process. Set to 0 for the alization Packet
	ulSrcId	UINT32	ulCANOPENSL d	Source End Point Identifier, specifying the origin of the packet de the Source Process
	ulLen	UINT32	64	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the rce Process of the Packet
	ulSta	UINT32		See section 6.2 *Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x2923	CANOPEN_SLAVE_SEND_TXPDO_CNF - Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch
tData	structure CANOPEN_SLAVE_SEND_TXPDO_CNF_DATA_T			
	aulSendTxPdoResult[]	UINT32[		Array of Results of sending TxPDOs

Table 82: CANOPEN_SLAVE_PACKET_SEND_TXPDO_CNF_T – Confirmation to Send TxPDO Request

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5.2.13 CANOPEN_SLAVE_RECV_RXPDO_REQ/CNF – Receive RxPDO Request

This packet sends one or more RTR Telegrams (CAN Remote Frames) to the CANopen network in order to request a RxPDO from a communication partner (CANopen Master or Slave). Issueing the request packet `CANOPEN_SLAVE_RECV_RXPDO_REQ` causes a CAN Remote Frame to be sent causing an indication at the communication partner. It is up to the communication partner to decide, whether it wants to react to this RTR Telegram, or not. In case of a positive decision, the communication partner will send a response with the requested application to the CANopen Slave.

Requesting can be done simultaneously for up to 16 RxPDOs, whose numbers must be assigned to the members of array `aulRecvRxPdoNumber[]` of the request packet.

The 16 RxPDOs will be processed separately and for each the resulting status code (success/error) will be stored in array `aulRecvRxPdoResult[]` of the confirmation packet

For details of the protocol, see the lower part of *Figure 17: CANopen PDO.Protocol.*

In *Figure 17: CANopen PDO.Protocol*, request(s) there relates to the `CANOPEN_SLAVE_RECV_RXPDO_REQ` packet and confirmation(s) to the `CANOPEN_SLAVE_RECV_RXPDO_CNF` packet.

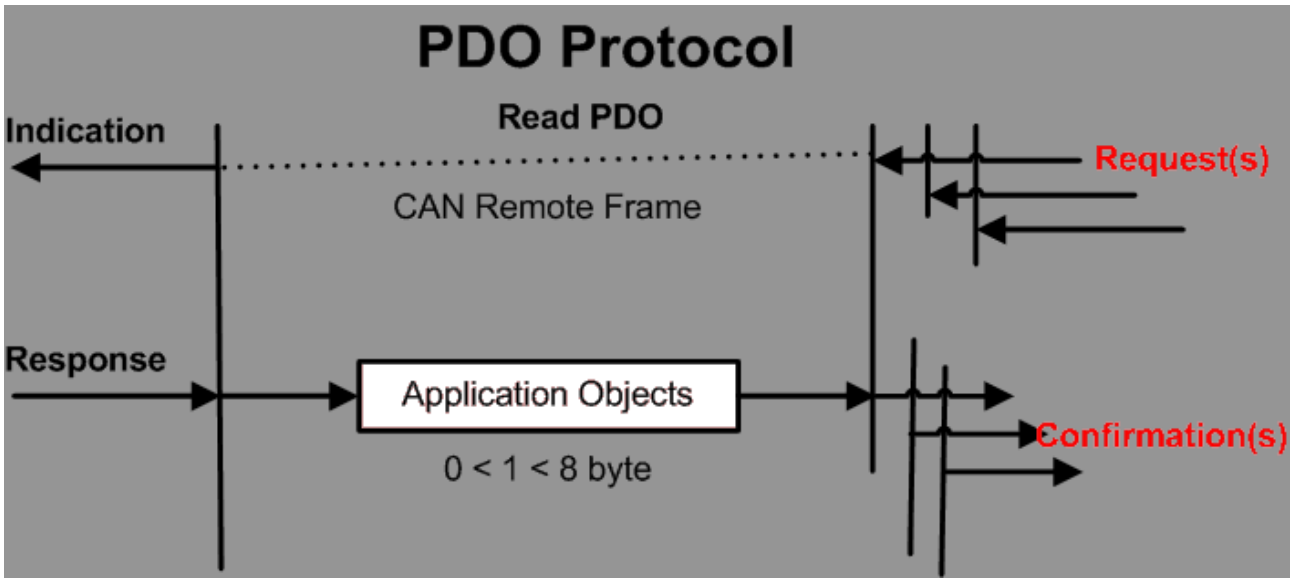

Figure 17: CANopen PDO.Protocol

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Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_RECV_RXPDO_REQ_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_RECV_RXPDO_REQ_DATA_Ttag
  CANOPEN_SLAVE_RECV_RXPDO_REQ_DATA_T;

#define CANOPEN_SLAVE_RECV_RXPDO_REQ_MAX    16

struct CANOPEN_SLAVE_RECV_RXPDO_REQ_DATA_Ttag
{
  TLR_UINT32 aulRecvRxPdoNumber[CANOPEN_SLAVE_RECV_RXPDO_REQ_MAX];
};

/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_RECV_RXPDO_REQ_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_RECV_RXPDO_REQ_Ttag
  CANOPEN_SLAVE_PACKET_RECV_RXPDO_REQ_T;

struct CANOPEN_SLAVE_PACKET_RECV_RXPDO_REQ_Ttag
{
  TLR_PACKET_HEADER_T                 tHead; /** packet header. */
  CANOPEN_SLAVE_RECV_RXPDO_REQ_DATA_T tData; /** packet data.   */
};

/*****************************************************************************/
```


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Packet Description

structure CANOPEN_SLAVE_PACKET_RECV_RXPDO_REQ_T				Type: Request
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle
	ulSrc	UINT32		Source Queue-Handle
	ulDestId	UINT32		Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process. Set to 0 for the Initialization Packet
	ulSrcId	UINT32		Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	64	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32	0	See section 6.2 *Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x2924	CANOPEN_SLAVE_RECV_RXPDO_REQ - Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch
tData	structure CANOPEN_SLAVE_RECV_RXPDO_REQ_DATA_T			
	aulRecvRxPdoNumber[]	UINT32 [16]	1..255 for each number	Array of numbers of RxPDOs to be received

Table 83: CANOPEN_SLAVE_PACKET_RECV_RXPDO_REQ_T - Receive RxPDO Request

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Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_RECV_RXPDO_CNF_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_RECV_RXPDO_CNF_DATA_Ttag
  CANOPEN_SLAVE_RECV_RXPDO_CNF_DATA_T;

#define CANOPEN_SLAVE_RECV_RXPDO_REQ_MAX    16

struct CANOPEN_SLAVE_RECV_RXPDO_CNF_DATA_Ttag
{
  TLR_UINT32 aulRecvRxPdoResult[CANOPEN_SLAVE_RECV_RXPDO_REQ_MAX];
};

/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_RECV_RXPDO_CNF_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_RECV_RXPDO_CNF_Ttag
  CANOPEN_SLAVE_PACKET_RECV_RXPDO_CNF_T;

struct CANOPEN_SLAVE_PACKET_RECV_RXPDO_CNF_Ttag
{
  TLR_PACKET_HEADER_T                 tHead; /** packet header. */
  CANOPEN_SLAVE_RECV_RXPDO_CNF_DATA_T tData; /** packet data.   */
};
/*****************************************************************************/
```

Packet Description

structure CANOPEN_SLAVE_PACKET_RECV_RXPDO_CNF_T				Type: Confirmation
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle
	ulSrc	UINT32		Source Queue-Handle
	ulDestId	UINT32		Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process. Set to 0 for the Initialization Packet
	ulSrcId	UINT32		Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	64	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32		See section 6.2 *Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x2925	CANOPEN_SLAVE_RECV_RXPDO_CNF - Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch
tData	structure CANOPEN_SLAVE_RECV_RXPDO_CNF_DATA_T			
	aulRecvRxPdoResult[]	UINT32[16]		Array of Results of received RxPDOs

Table 84: CANOPEN_SLAVE_PACKET_RECV_RXPDO_CNF_T – Confirmation to Receive RxPDO Request

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5.2.14 CANOPEN_SLAVE_RECV_RXPDO_IND/RES – Receive RxPDO Indication

This packet indicates the the arrival of new process data from a communication partner (CANopen Master or a Slave), i.e. the reception of one or more PDOs. Sending a response does not send new telegrams or execute other reactions.

The packet can simultaneously indicate requests of the communication partner for up to 16 RxPDOs, whose numbers are transmitted by the members of array `aulRecvRxPdoNumber[]` of the request packet.

The 16 RxPDOs will be processed separately and for each the resulting status code (success/error) will be stored in the parameter array `aulRecvRxPdoResult[]` of the indication packet.

The response packet does not have any parameters

PDO communication works based on the producer/consumer model:

- the CANopen Slave acts as a consumer here,
- the communication partner acts as producer.

For details of the protocol, see the lower part of *Figure 18: CANopen PDO.Protocol.*

Indication there relates to the `CANOPEN_SLAVE_RECV_RXPDO_IND` packet and Response to the `CANOPEN_SLAVE_RECV_RXPDO_RES` packet.

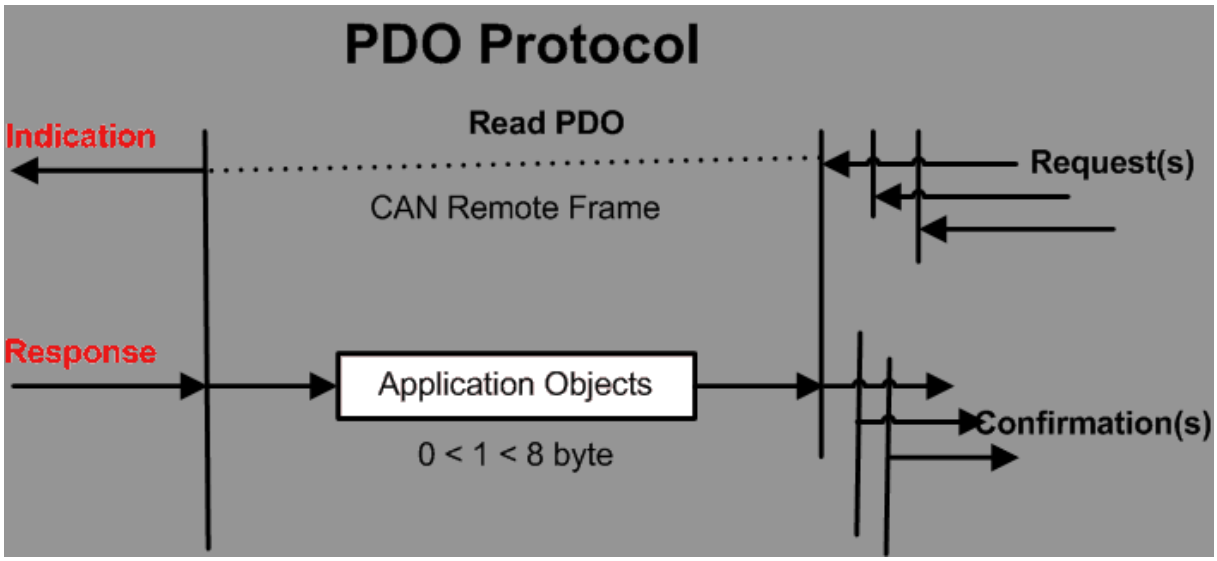

Figure 18: CANopen PDO.Protocol

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Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_RECV_RXPDO_IND_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_RECV_RXPDO_IND_DATA_Ttag
  CANOPEN_SLAVE_RECV_RXPDO_IND_DATA_T;

#define CANOPEN_SLAVE_RECV_RXPDO_IND_MAX    16

 struct CANOPEN_SLAVE_RECV_RXPDO_IND_DATA_Ttag
{
  TLR_UINT32 aulRecvRxPdoNumber[CANOPEN_SLAVE_RECV_RXPDO_IND_MAX];

};

/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_RECV_RXPDO_IND_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_RECV_RXPDO_IND_Ttag
  CANOPEN_SLAVE_PACKET_RECV_RXPDO_IND_T;

struct CANOPEN_SLAVE_PACKET_RECV_RXPDO_IND_Ttag
{
  TLR_PACKET_HEADER_T                 tHead; /** packet header. */
  CANOPEN_SLAVE_RECV_RXPDO_IND_DATA_T tData; /** packet data.   */

};
/*****************************************************************************/
```

Packet Description

structure CANOPEN_SLAVE_PACKET_RECV_RXPDO_IND_T				**Type: Indication**
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle
	ulSrc	UINT32		Source Queue-Handle
	ulDestId	UINT32	ulAPSS0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process. Set to 0 for the Initialization Packet
	ulSrcId	UINT32	ulCANOPENSLV0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	64	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32		See section 6.2 *Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x2926	CANOPEN_SLAVE_RECV_RXPDO_IND - Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch
tData	structure CANOPEN_SLAVE_RECV_RXPDO_IND_DATA_T			
	aulRecvRxPdoNumber []	UINT32[16]	1..255 for each number	Array of numbers of received RxPDOs

Table 85: CANOPEN_SLAVE_PACKET_RECV_RXPDO_IND_T –Receive RxPDO Indication

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Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_RECV_RXPDO_RES_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_RECV_RXPDO_RES_Ttag
  CANOPEN_SLAVE_PACKET_RECV_RXPDO_RES_T;

struct CANOPEN_SLAVE_PACKET_RECV_RXPDO_RES_Ttag
{
  TLR_PACKET_HEADER_T tHead; /** packet header. */
};
/*****************************************************************************/
```

Packet Description

structure CANOPEN_SLAVE_PACKET_RECV_RXPDO_RES_T				**Type: Response**
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle
	ulSrc	UINT32		Source Queue-Handle
	ulDestId	UINT32	ulCANOPENSLV0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process. Set to 0 for the Initialization Packet
	ulSrcId	UINT32	ulAPSS0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	0	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32		See section 6.2 *Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x2927	CANOPEN_SLAVE_RECV_RXPDO_RES - Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch

Table 86: CANOPEN_SLAVE_PACKET_RECV_RXPDO_RES_T – Response to Receive RxPDO Indication

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5.2.15 CANOPEN_SLAVE_SET_EVENTS_INDICATED_REQ/CNF – Set Events Indicated Request

Note: This packet will be denied in case of being called as long as the 'Configuration lock' flag of the netX is set!

The following types of indications may occur in the CANopen Protocol Stack V3 and indicate that a specific event has happened:

- NMT State Change Event (CANOPEN_SLAVE_NMT_STATE_CHANGE_IND/RES – NMT State Change Indication, for more information see page 147)
- Time Stamp Event (CANOPEN_SLAVE_RECV_TIME_STAMP_IND/RES – Receive Time Stamp Indication, for more information see page 125)
- Error Control Event (CANOPEN_SLAVE_ERR_CTRL_EVENT_IND/RES – Error Control Event Indication, for more information see page 150)
- Receive PDO Event (CANOPEN_SLAVE_RECV_RXPDO_IND/RES – Receive RxPDO Indication, for more information see page 135)
- NMT Command Event (CANOPEN_SLAVE_NMT_COMMAND_IND/RES – NMT Command Indication, for more information see page 154)
- Send EMCY Event (CANOPEN_SLAVE_SEND_EMCY_IND/RES – Emergency Message Indication, for more information see page 110)

Each type of indication is associated to a bit of the bit mask contained in variable ulEventsIndicated in the following manner:

Type	Bit No.	Mask (numeric value)	Mask (symbolic name)
NMT State Change Event	0	0x01	CANOPEN_SLAVE_EVENT_NMT_STATE_CHANGE_MSK
Time Stamp Event	1	0x02	CANOPEN_SLAVE_EVENT_TIME_STAMP_MSK
Error Control Event	2	0x04	CANOPEN_SLAVE_EVENT_ERR_CTRL_MSK
Receive PDO Event	3	0x08	CANOPEN_SLAVE_EVENT_RECV_RXPDO_MSK
NMT Command Event	4	0x10	CANOPEN_SLAVE_EVENT_NMT_COMMAND_MSK
Send EMCY Event	5	0x20	CANOPEN_SLAVE_EVENT_SEND_EMCY_MSK

Table 87: Bit Mask ulEventsIndicated

Each of these bits within the bit mask of ulEventsIndicated allows switching on (when set to 1) and off (when set to 0) the associated type of event indication.

The higher bits of ulEventsIndicated should always be set to 0.

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The NMT State Change Events include the Module Control Services described in the CANopen Specification CiA Draft Standard 301, subsection 9.2.6.1.1.

These are:

- Start Remote Node
- Stop Remote Node
- Enter Pre-Operational
- Reset Node
- Reset Communication

The Error Control Events allow detecting errors within the CAN network. They include the following types of events described in the CANopen Specification CiA Draft Standard 301, subsection 9.2.6.1.2:

- Node Guarding Event
- Life Guarding Event
- Heartbeat Event

There is one single type of Time Stamp Event defined in CANopen which can be handled by the `CANOPEN_SLAVE_RECV_TIME_STAMP_IND/RES` – Receive Time Stamp Indication in the CANopen Slave V3 protocol stack.

Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_SET_EVENTS_INDICATED_REQ_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_SET_EVENTS_INDICATED_REQ_DATA_Ttag
  CANOPEN_SLAVE_SET_EVENTS_INDICATED_REQ_DATA_T;

#define CANOPEN_SLAVE_EVENT_NMT_STATE_CHANGE_MSK 0x00000001L
#define CANOPEN_SLAVE_EVENT_TIME_STAMP_MSK       0x00000002L
#define CANOPEN_SLAVE_EVENT_ERR_CTRL_MSK         0x00000004L
#define CANOPEN_SLAVE_EVENT_RECV_RXPDO_MSK       0x00000008L
#define CANOPEN_SLAVE_EVENT_NMT_COMMAND_MSK      0x00000010L
#define CANOPEN_SLAVE_EVENT_SEND_EMCY_MSK        0x00000020L
#define CANOPEN_SLAVE_EVENT_RESERVED_MSK         0xFFFFFFC0L

struct CANOPEN_SLAVE_SET_EVENTS_INDICATED_REQ_DATA_Ttag
{
  TLR_UINT32 ulEventsIndicated;

};

/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_SET_EVENTS_INDICATED_REQ_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_SET_EVENTS_INDICATED_REQ_Ttag
  CANOPEN_SLAVE_PACKET_SET_EVENTS_INDICATED_REQ_T;

struct CANOPEN_SLAVE_PACKET_SET_EVENTS_INDICATED_REQ_Ttag
{
  TLR_PACKET_HEADER_T                          tHead; /** packet header. */
  CANOPEN_SLAVE_SET_EVENTS_INDICATED_REQ_DATA_T tData; /** packet data.   */
};
/*****************************************************************************/
```


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Packet Description

structure CANOPEN_SLAVE_PACKET_SET_EVENTS_INDICATED_REQ_T				Type: Request
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	structure TLR_PACKET_HEADER_T			
	ulDest	UINT32	0x20/ QUE_CANOPEN SLV	Destination Queue-Handle
	ulSrc	UINT32	0 ... 2^{32}-1	Source Queue-Handle
	ulDestId	UINT32	ulCANOPENSL V0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process. Set to 0 for the Initialization Packet
	ulSrcId	UINT32	ulAPSS0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	4	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32	0	See section 6.2 *Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x2928	CANOPEN_SLAVE_SET_EVENTS_INDICATED_REQ - Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch
tData	structure CANOPEN_SLAVE_SET_EVENTS_INDICATED_REQ_DATA_T			
	ulEventsIndicated	UINT32	Bit mask	Indicated events

Table 88: CANOPEN_SLAVE_PACKET_SET_EVENTS_INDICATED_REQ_T - Set Events Indicated Request

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Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_SET_EVENTS_INDICATED_CNF_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_SET_EVENTS_INDICATED_CNF_Ttag
  CANOPEN_SLAVE_PACKET_SET_EVENTS_INDICATED_CNF_T;

struct CANOPEN_SLAVE_PACKET_SET_EVENTS_INDICATED_CNF_Ttag
{
  TLR_PACKET_HEADER_T tHead;                        /** packet header. */

};
/*****************************************************************************/
```

Packet Description

structure CANOPEN_SLAVE_PACKET_SET_EVENTS_INDICATED_CNF_T				**Type: Confirmation**
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle
	ulSrc	UINT32		Source Queue-Handle
	ulDestId	UINT32		Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process. Set to 0 for the Initialization Packet
	ulSrcId	UINT32		Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	0	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32		See section 6.2 *Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x2929	CANOPEN_SLAVE_SET_EVENTS_INDICATED_CNF - Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch

Table 89: CANOPEN_SLAVE_PACKET_SET_EVENTS_INDICATED_CNF_T – Confirmation to Set Events Indicated Request

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5.2.16 CANOPEN_SLAVE_GET_IO_INFO_REQ/CNF – Get I/O Info

This packet can be used to retrieve the counts of received data (Variable `ulRecvDataCnt` of confirmation packet) and send data (Variable `ulSendDataCnt` of confirmation packet) in CANopen data communication.

Note: This information is also part of the slave state, see section 5.2.5 .CANOPEN_SLAVE_STATE_CHANGE_IND/RES – Change of Task State Indication.

Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_GET_IO_INFO_REQ_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_GET_IO_INFO_REQ_Ttag
  CANOPEN_SLAVE_PACKET_GET_IO_INFO_REQ_T;

struct CANOPEN_SLAVE_PACKET_GET_IO_INFO_REQ_Ttag
{
  TLR_PACKET_HEADER_T tHead;                  /** packet header.           */
};

/*****************************************************************************/
```

Packet Description

structure CANOPEN_SLAVE_PACKET_GET_IO_INFO_REQ_T				Type: Request
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	structure TLR_PACKET_HEADER_T			
	ulDest	UINT32	0x20/ QUE_CANOPEN SLV	Destination Queue-Handle
	ulSrc	UINT32	0 ... 2^{32}-1	Source Queue-Handle
	ulDestId	UINT32	ulCANOPENSL V0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process. Set to 0 for the Initialization Packet
	ulSrcId	UINT32	ulAPSS0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	0	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32	*0*	See section 6.2 *Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x292A	CANOPEN_SLAVE_GET_IO_INFO_REQ - Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch

Table 90: CANOPEN_SLAVE_PACKET_GET_IO_INFO_REQ_T - Get I/O Info Request

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Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_GET_IO_INFO_CNF_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_GET_IO_INFO_CNF_DATA_Ttag
  CANOPEN_SLAVE_GET_IO_INFO_CNF_DATA_T;

struct CANOPEN_SLAVE_GET_IO_INFO_CNF_DATA_Ttag
{
  TLR_UINT32 ulRecvDataCnt;
  TLR_UINT32 ulSendDataCnt;
};

/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_GET_IO_INFO_CNF_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_GET_IO_INFO_CNF_Ttag
  CANOPEN_SLAVE_PACKET_GET_IO_INFO_CNF_T;

struct CANOPEN_SLAVE_PACKET_GET_IO_INFO_CNF_Ttag
{
  TLR_PACKET_HEADER_T                  tHead; /** packet header.            */
  CANOPEN_SLAVE_GET_IO_INFO_CNF_DATA_T tData; /** packet confirmation data. */
};

/*****************************************************************************/
```

Packet Description

structure CANOPEN_SLAVE_PACKET_GET_IO_INFO_CNF_T				**Type: Confirmation**
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle
	ulSrc	UINT32		Source Queue-Handle
	ulDestId	UINT32	ulAPSS0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process. Set to 0 for the Initialization Packet
	ulSrcId	UINT32	ulCANOPENSLV0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	8	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32		See section 6.2 *Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x292B	CANOPEN_SLAVE_GET_IO_INFO_CNF - Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch
tData	structure CANOPEN_SLAVE_GET_IO_INFO_CNF_DATA_T			
	ulRecvDataCnt	UINT32	0 ... 2^{32}-1	Receive Data Count
	ulSendDataCnt	UINT32	0 ... 2^{32}-1	Send Data Count

Table 91: CANOPEN_SLAVE_PACKET_GET_IO_INFO_CNF_T – Confirmation to Get I/O Info Request

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5.2.17 CANOPEN_SLAVE_SET_API_PARAM_REQ/CNF – Set API Parameter

This packet can be used to register callbacks for data exchange between Slave and APS task at the CANopen Slave.

Note: Use this packet only when working with linkable object modules. It has not been designed for usage in the context of loadable firmware.

Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_SET_API_PARAM_REQ_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_SET_API_PARAM_REQ_DATA_Ttag
  CANOPEN_SLAVE_SET_API_PARAM_REQ_DATA_T;

typedef TLR_VOID (CALLBACK FAR* PFN_CANOPEN_SLAVE_CALLBACK)
(
TLR_HANDLE hApplication
);

struct CANOPEN_SLAVE_SET_API_PARAM_REQ_DATA_Ttag
{
  TLR_HANDLE hApplication;

  PFN_CANOPEN_SLAVE_CALLBACK pFncSendDataUpdated;
  TLR_UINT8 FAR* pbSrcData;
  TLR_UINT32 ulSrcDataCnt;

  PFN_CANOPEN_SLAVE_CALLBACK pFncRecvDataUpdated;
  TLR_UINT8 FAR* pbDstData;
  TLR_UINT32 ulDstDataCnt;
};

/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_SET_API_PARAM_REQ_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_SET_API_PARAM_REQ_Ttag
  CANOPEN_SLAVE_PACKET_SET_API_PARAM_REQ_T;

struct CANOPEN_SLAVE_PACKET_SET_API_PARAM_REQ_Ttag
{
  TLR_PACKET_HEADER_T                      tHead; /** packet header.         */
  CANOPEN_SLAVE_SET_API_PARAM_REQ_DATA_T   tData; /** packet request data.   */

};
/*****************************************************************************/
```


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Packet Description

structure CANOPEN_SLAVE_PACKET_SET_API_PARAM_REQ_T				Type: Request
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	structure TLR_PACKET_HEADER_T			
	ulDest	UINT32	0x20/ QUE_CANOPEN SLV	Destination Queue-Handle
	ulSrc	UINT32	0 ... 2^{32}-1	Source Queue-Handle
	ulDestId	UINT32	ulCANOPENSL V0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process. Set to 0 for the Initialization Packet
	ulSrcId	UINT32	ulAPSS0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32		Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32	0	See section 6.2 *Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x292C	CANOPEN_SLAVE_SET_API_PARAM_REQ - Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch
tData	structure CANOPEN_SLAVE_SET_API_PARAM_REQ_DATA_T			
	hApplication	TLR_HA NDLE		Application Handle of Slave (see TLR Manual)
	pFncSendDataUp dated	PFN_CA NOPEN _SLAVE _CALLB ACK	Callback	Callback for Send Data
	pbSrcData	UINT8 FAR*	Pointer	Source Data Pointer
	ulSrcDataCnt	UINT32	0 ... 2^{32}-1	Source Data Count
	pFncRecvDataUp dated	PFN_CA NOPEN _SLAVE _CALLB ACK	Callback	Callback for Receive Data
	pbDstData	UINT8 FAR*	Pointer	Destination Data Pointer
	ulDstDataCnt	UINT32	0 ... 2^{32}-1	Destination Data Count

Table 92: CANOPEN_SLAVE_PACKET_SET_API_PARAM_REQ_T - Set API Parameter Request

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Packet Structure Reference

```
/*****************************************************************************/
typedef struct CANOPEN_SLAVE_SET_API_PARAM_CNF_DATA_Ttag
  CANOPEN_SLAVE_SET_API_PARAM_CNF_DATA_T;

typedef TLR_VOID (CALLBACK FAR* PFN_CANOPEN_SLAVE_CALLBACK)
(
TLR_HANDLE hApplication
);

struct CANOPEN_SLAVE_SET_API_PARAM_CNF_DATA_Ttag
{
  TLR_HANDLE hSlave;
};

/** type of <code>CANOPEN_SLAVE_PACKET_SET_API_PARAM_CNF_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_SET_API_PARAM_CNF_Ttag
  CANOPEN_SLAVE_PACKET_SET_API_PARAM_CNF_T;

struct CANOPEN_SLAVE_PACKET_SET_API_PARAM_CNF_Ttag
{
  TLR_PACKET_HEADER_T                    tHead; /** packet header.            */
  CANOPEN_SLAVE_SET_API_PARAM_CNF_DATA_T tData; /** packet confirmation data. */
};
/*****************************************************************************/
```

Packet Description

structure CANOPEN_SLAVE_PACKET_SET_API_PARAM_CNF_T				**Type: Confirmation**
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle
	ulSrc	UINT32		Source Queue-Handle
	ulDestId	UINT32	ulAPSS0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process. Set to 0 for the Initialization Packet
	ulSrcId	UINT32	ulCANOPENSLV0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32		Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32		See section 6.2 *Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x292D	CANOPEN_SLAVE_SET_API_PARAM_CNF - Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch
tData	structure CANOPEN_SLAVE_SET_API_PARAM_CNF_DATA_T			
	hSlave	TLR_HANDLE		Slave Handle (see TLR Manual)

Table 93: CANOPEN_SLAVE_PACKET_SET_API_PARAM_CNF_T - Confirmation to Set API Parameter Request

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5.2.18 CANOPEN_SLAVE_NMT_STATE_CHANGE_IND/RES – NMT State Change Indication

This packet indicates a change in the CANopen Slave's own NMT State Machine. The new state is delivered with the indication packets `ulNmtState` variable.

The relation between the values and the states is as follows:

Value	Symbolic Name	State	Sub-state
1	CANOPEN_SLAVE_NMT_STATE_OPERATIONAL	*Operational*	-
2	CANOPEN_SLAVE_NMT_STATE_STOP	*Stop*	-
128	CANOPEN_SLAVE_NMT_STATE_PRE_OPERATIONAL	*Pre-operational*	-
129	CANOPEN_SLAVE_NMT_STATE_RESET_NODE	*Initialization*	*Reset Node*
130	CANOPEN_SLAVE_NMT_STATE_RESET_COMM	*Initialization*	*Reset Communication*

Table 94: NMT States

This indication packet allows the application to react and perform all necessary application-internal changes after the change of NMT state. After having performed these, the application should send the CANOPEN_SLAVE_NMT_STATE_CHANGE_RES response packet to the CANopen Master.

For possible reasons of changes of NMT Slave states see section "*NMT State Change Events*" on page 52.

Packet Structure Reference

```
/*****************************************************************************
***/
/** type of <code>CANOPEN_SLAVE_NMT_STATE_CHANGE_IND_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_NMT_STATE_CHANGE_IND_DATA_Ttag
  CANOPEN_SLAVE_NMT_STATE_CHANGE_IND_DATA_T;

 struct CANOPEN_SLAVE_NMT_STATE_CHANGE_IND_DATA_Ttag
{
  TLR_UINT32 ulNmtState;
};

/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_NMT_STATE_CHANGE_IND_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_NMT_STATE_CHANGE_IND_Ttag
  CANOPEN_SLAVE_PACKET_NMT_STATE_CHANGE_IND_T;

struct CANOPEN_SLAVE_PACKET_NMT_STATE_CHANGE_IND_Ttag
{
  TLR_PACKET_HEADER_T                      tHead; /** packet header. */
  CANOPEN_SLAVE_NMT_STATE_CHANGE_IND_DATA_T tData; /** packet data.   */
};
/*****************************************************************************/
```


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Packet Description

structure CANOPEN_SLAVE_PACKET_NMT_STATE_CHANGE_IND_T				Type: Indication
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle
	ulSrc	UINT32		Source Queue-Handle
	ulDestId	UINT32	ulAPSS0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process. Set to 0 for the Initialization Packet
	ulSrcId	UINT32	ulCANOPENSLV0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	4	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32		See section 6.2 *Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x292E	CANOPEN_SLAVE_NMT_STATE_CHANGE_IND - Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch
tData	structure CANOPEN_SLAVE_NMT_STATE_CHANGE_IND_DATA_T			
	ulNmtState	UINT32	1,2,128..130	New NMT State, see *Table 72: NMT States*

Table 95: CANOPEN_SLAVE_PACKET_NMT_STATE_CHANGE_IND_T - NMT State Change Indication

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Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_NMT_STATE_CHANGE_RES_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_NMT_STATE_CHANGE_RES_Ttag
  CANOPEN_SLAVE_PACKET_NMT_STATE_CHANGE_RES_T;

struct CANOPEN_SLAVE_PACKET_NMT_STATE_CHANGE_RES_Ttag
{
  TLR_PACKET_HEADER_T  tHead; /** packet header. */
};
/*****************************************************************************/
```

Packet Description

structure CANOPEN_SLAVE_PACKET_NMT_STATE_CHANGE_RES_T				**Type: Response**
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle
	ulSrc	UINT32		Source Queue-Handle
	ulDestId	UINT32	ulCANOPENSLV0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process. Set to 0 for the Initialization Packet
	ulSrcId	UINT32	ulAPSS0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	0	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32		See section 6.2 *Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x292F	CANOPEN_SLAVE_NMT_STATE_CHANGE_RES - Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch

Table 96: CANOPEN_SLAVE_PACKET_NMT_STATE_CHANGE_RES_T – Response to NMT State Change Indication

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5.2.19 CANOPEN_SLAVE_ERR_CTRL_EVENT_IND/RES – Error Control Event Indication

In a CANopen network, the Master supervises the error control of the entire network and is aware of all changes of the error control state. Additionally, it even shares this knowledge with the slaves by informing these on the most current changes.

This is exactly done with the indication packet `CANOPEN_SLAVE_ERR_CTRL_EVENT_IND` described here, which indicates the occurrence of one or more Error Control Event(s) i.e. changes of the error control state within the entire CANopen network, and informs the CANopen Slave.

Error Control Events allow detecting errors within the CAN network. They include the following types of events occurring at the slave described in the CANopen Specification CiA Draft Standard 301, subsection 9.2.6.1.2:

- Life Guarding Event
- Heartbeat Event

For each change of a node's error control state there is an entry in the array of structures `atErrCtrlEvent[16]` Each array element contains the following structure:

Name	Meaning	Data type	Range of Values
`ulEvent`	Type of event that has happened	UINT32	1…6
`ulNodeId`	Node-ID	UINT32	1…127

Table 97: Array Elements of `atErrCtrlEvent[16]`

The meaning of the values of `ulEvent` is defined as follows:

Value	Symbolic Name	Meaning
1	`CANOPEN_SLAVE_HEARTBEAT_STARTED`	Heartbeat Start for affected node with ID `ulNodeId`
2	`CANOPEN_SLAVE_HEARTBEAT_ERROR`	Heartbeat Error for affected node with ID `ulNodeId`
3	`CANOPEN_SLAVE_HEARTBEAT_STOPPED`	Heartbeat Stop for affected node with ID `ulNodeId`
4	`CANOPEN_SLAVE_LIFE_GUARD_STARTED`	Lifeguard Start for affected node with ID `0`
5	`CANOPEN_SLAVE_LIFE_GUARD_ERROR`	Lifeguard Error for affected node with ID `0`
6	`CANOPEN_SLAVE_LIFE_GUARD_STOPPED`	Lifeguard Stop for affected node with ID `0`

Table 98: Possible Values of ulEvent and their Meanings

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Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_ERR_CTRL_EVENT_IND_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_ERR_CTRL_EVENT_IND_DATA_Ttag
  CANOPEN_SLAVE_ERR_CTRL_EVENT_IND_DATA_T;
/** type of <code>CANOPEN_SLAVE_ERR_CTRL_EVENT_Ttag</code> */
typedef struct CANOPEN_SLAVE_ERR_CTRL_EVENT_Ttag
  CANOPEN_SLAVE_ERR_CTRL_EVENT_T;

#define CANOPEN_SLAVE_MAX_ERR_CTRL_EVENT  16

#define CANOPEN_SLAVE_HEARTBEAT_STARTED   0x00000001L
#define CANOPEN_SLAVE_HEARTBEAT_ERROR     0x00000002L
#define CANOPEN_SLAVE_HEARTBEAT_STOPPED   0x00000003L

#define CANOPEN_SLAVE_LIFE_GUARD_STARTED  0x00000004L
#define CANOPEN_SLAVE_LIFE_GUARD_ERROR    0x00000005L
#define CANOPEN_SLAVE_LIFE_GUARD_STOPPED  0x00000006L

 struct CANOPEN_SLAVE_ERR_CTRL_EVENT_Ttag
{
  TLR_UINT32 ulEvent;
  TLR_UINT32 ulNodeId;

};

 struct CANOPEN_SLAVE_ERR_CTRL_EVENT_IND_DATA_Ttag
{
  CANOPEN_SLAVE_ERR_CTRL_EVENT_T atErrCtrlEvent[CANOPEN_SLAVE_MAX_ERR_CTRL_EVENT];
};

/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_ERR_CTRL_EVENT_IND_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_ERR_CTRL_EVENT_IND_Ttag
  CANOPEN_SLAVE_PACKET_ERR_CTRL_EVENT_IND_T;

struct CANOPEN_SLAVE_PACKET_ERR_CTRL_EVENT_IND_Ttag
{
  TLR_PACKET_HEADER_T                    tHead; /** packet header. */
  CANOPEN_SLAVE_ERR_CTRL_EVENT_IND_DATA_T tData; /** packet data.   */
};
/*****************************************************************************/
```


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Packet Description

structure CANOPEN_SLAVE_PACKET_ERR_CTRL_EVENT_IND_T				Type: Indication
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle
	ulSrc	UINT32		Source Queue-Handle
	ulDestId	UINT32	ulAPSS0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process. Set to 0 for the Initialization Packet
	ulSrcId	UINT32	ulCANOPENSLV0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32		Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32		See section 6.2 *Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x2930	CANOPEN_SLAVE_ERR_CTRL_EVENT_IND - Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch
tData	structure CANOPEN_SLAVE_ERR_CTRL_EVENT_IND_DATA_T			
	atErrCtrlEvent[]	CANOPEN_SLAVE_ERR_CTRL_EVENT_T[16]		Structure containing up to 16 Error Control Events. Also see *Table 97: Array Elements of atErrCtrlEvent[16]* and *Table 98: Possible Values of ulEvent and their Meanings.*

Table 99: CANOPEN_SLAVE_PACKET_ERR_CTRL_EVENT_IND_T - Error Control Event Indication

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Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_NMT_STATE_CHANGE_RES_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_ERR_CTRL_EVENT_RES_Ttag
  CANOPEN_SLAVE_PACKET_ERR_CTRL_EVENT_RES_T;

struct CANOPEN_SLAVE_PACKET_ERR_CTRL_EVENT_RES_Ttag
{
  TLR_PACKET_HEADER_T  tHead; /** packet header. */

};
/*****************************************************************************/
```

Packet Description

structure CANOPEN_SLAVE_PACKET_ERR_CTRL_EVENT_RES_T				**Type: Response**
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle
	ulSrc	UINT32		Source Queue-Handle
	ulDestId	UINT32	ulCANOPENSLV0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process. Set to 0 for the Initialization Packet
	ulSrcId	UINT32	ulAPSS0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	0	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32		See section 6.2 *Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x2931	CANOPEN_SLAVE_ERR_CTRL_EVENT_RES - Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch

Table 100: CANOPEN_SLAVE_PACKET_ERR_CTRL_EVENT_RES_T – Response to Error Control Event Indication

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5.2.20 CANOPEN_SLAVE_NMT_COMMAND_IND/RES – NMT Command Indication

The CANopen Network Management (NMT) within the CANopen Master provides services for initializing, starting, monitoring, resetting and stopping CANopen Slaves. These are also called the Module Control Services

Each time such a service is requested, a CANOPEN_SLAVE_NMT_COMMAND_IND indication is received. This enables the host application to react to the requests of the CANopen Master. Which action should be taken, depends on the value of variable `ulNmtCommand` in the following manner:

Value	Symbolic Name	Meaning/ Action to take
1	CANOPEN_SLAVE_NMT_STATE_OPERATIONAL	Set state to *Operational*
2	CANOPEN_SLAVE_NMT_STATE_STOP	Set state to *Stopped*
128	CANOPEN_SLAVE_NMT_STATE_PRE_OPERATIONAL	Set state to *Pre-operational*
129	CANOPEN_SLAVE_NMT_STATE_RESET_NODE	Reset node
130	CANOPEN_SLAVE_NMT_STATE_RESET_COMM	Reset communication

Table 101: NMT States

Reset communication should set the state to *Initialization*, sub-state *Reset Communication*.

This means first restoring the communication profile area of the Object Dictionary with the power-on values and then run the initialization process like after power-on.

Reset node should set the state to *Initialization*, sub-state *Reset Application*.

This means first restoring the manufacturer-specific area and the device profile area of the slave's Object Dictionary with the default values, then restoring the communication profile area of the Object Dictionary with the power-on values and finally run the initialization process like after power-on.

The NMT Protocol associated with the NMT Command Event is illustrated in *Figure 19: NMT Protocol.*

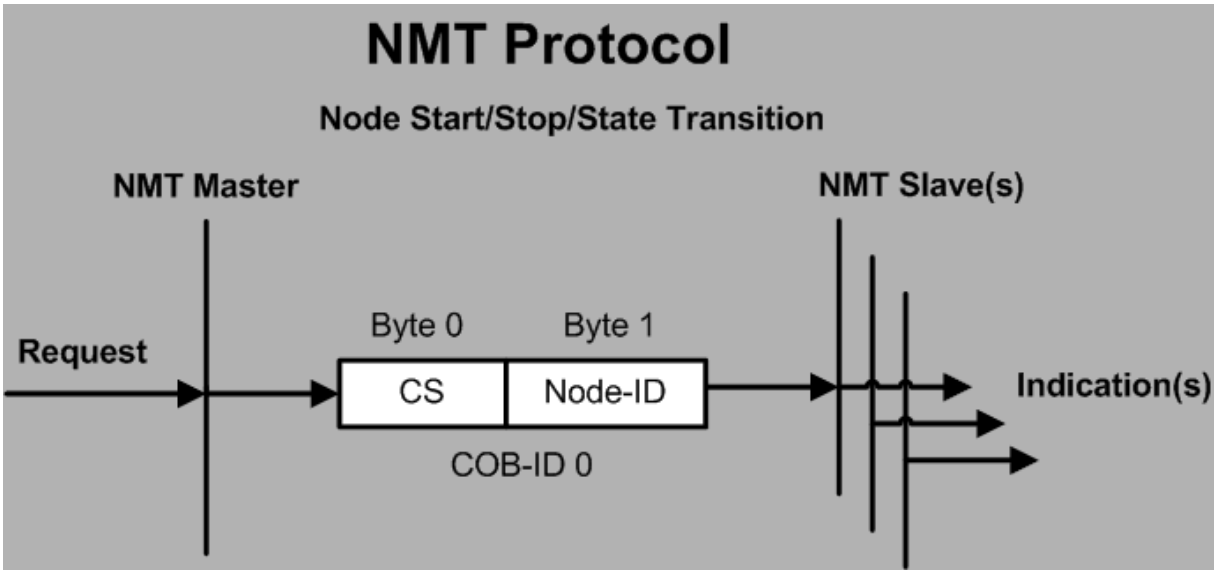

Figure 19: NMT Protocol

In this figure, CS (Command Specifier) means the value of variable `ulNmtCommand`.

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When the application receives the CANOPEN_SLAVE_NMT_COMMAND_IND indication, it should try to do everything required to set the slave into the state having been requested. However, this may not be possible in all situations. So there is the possibility to leave the slave in another state than the requested one.

In any case, the application needs to send a response packet. The current state after processing the CANOPEN_SLAVE_NMT_COMMAND_IND indication needs to be supplied in the response packets `ulNmtState` variable. As NMT is an unconfirmed service, the response is not sent to the CANopen Master, but required for internal use at the CANopen Slave.

Packet Structure Reference

```
/*****************************************************************************/
 * NMT states for CANOPEN SLAVE SET NMT STATE REQ,
 * CANOPEN SLAVE NMT STATE CHANGE IND and
 * CANOPEN SLAVE NMT COMMAND IND
/*****************************************************************************/
#define CANOPEN_SLAVE_NMT_STATE_OPERATIONAL       0x01
#define CANOPEN_SLAVE_NMT_STATE_STOP              0x02
#define CANOPEN_SLAVE_NMT_STATE_PRE_OPERATIONAL   0x80
#define CANOPEN_SLAVE_NMT_STATE_RESET_NODE        0x81
#define CANOPEN_SLAVE_NMT_STATE_RESET_COMM        0x82
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_NMT_COMMAND_IND_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_NMT_COMMAND_IND_DATA_Ttag
  CANOPEN_SLAVE_NMT_COMMAND_IND_DATA_T;

 struct CANOPEN_SLAVE_NMT_COMMAND_IND_DATA_Ttag
{
  TLR_UINT32 ulNmtCommand;  /* Request NMT command from NMT master */

};/*****************************************************************************
*/
/** type of <code>CANOPEN_SLAVE_PACKET_NMT_COMMAND_IND_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_NMT_COMMAND_IND_Ttag
 CANOPEN_SLAVE_PACKET_NMT_COMMAND_IND_T;

struct CANOPEN_SLAVE_PACKET_NMT_COMMAND_IND_Ttag
{
  TLR_PACKET_HEADER_T                  tHead; /** packet header. */
  CANOPEN_SLAVE_NMT_COMMAND_IND_DATA_T tData; /** packet data.   */
};
/*****************************************************************************/
```


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Packet Description

structure CANOPEN_SLAVE_PACKET_NMT_COMMAND_IND_T				Type: Indication
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle
	ulSrc	UINT32		Source Queue-Handle
	ulDestId	UINT32	ulAPSS0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process. Set to 0 for the Initialization Packet
	ulSrcId	UINT32	ulCANOPENSLV0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	4	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32		See section 6.2 *Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x2932	CANOPEN_SLAVE_NMT_COMMAND_IND - Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch
tData	structure CANOPEN_SLAVE_NMT_COMMAND_IND_DATA_T			
	ulNmtCommand	UINT32	Valid NMT command	Requested NMT command from NMT master

Table 102: CANOPEN_SLAVE_PACKET_NMT_COMMAND_IND_T - NMT Command Indication

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Packet Structure Reference

```
/*****************************************************************************/
typedef struct CANOPEN_SLAVE_NMT_COMMAND_RES_DATA_Ttag
  CANOPEN_SLAVE_NMT_COMMAND_RES_DATA_T;

 struct CANOPEN_SLAVE_NMT_COMMAND_RES_DATA_Ttag
{
  TLR_UINT32 ulNmtState;  /* New local NMT state */

};

/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_NMT_COMMAND_RES_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_NMT_COMMAND_RES_Ttag
 CANOPEN_SLAVE_PACKET_NMT_COMMAND_RES_T;

struct CANOPEN_SLAVE_PACKET_NMT_COMMAND_RES_Ttag
{
  TLR_PACKET_HEADER_T                  tHead; /** packet header. */
  CANOPEN_SLAVE_NMT_COMMAND_RES_DATA_T tData; /** packet data.   */

};
/*****************************************************************************/
```

Packet Description

structure CANOPEN_SLAVE_PACKET_NMT_COMMAND_RES_T				**Type: Response**
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle
	ulSrc	UINT32		Source Queue-Handle
	ulDestId	UINT32	ulCANOPENSLV0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process. Set to 0 for the Initialization Packet
	ulSrcId	UINT32	ulAPSS0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32		Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32		See section 6.2 *Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x2933	CANOPEN_SLAVE_NMT_COMMAND_RES - Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch
tData	structure CANOPEN_SLAVE_NMT_COMMAND_RES_DATA_T			
	ulNmtState	UINT32	Valid NMT State	New local NMT state

Table 103: CANOPEN_SLAVE_PACKET_NMT_COMMAND_RES_T – Response to NMT Command Indication

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5.2.21 CANOPEN_SLAVE_GET_BUSPARAM_REQ/CNF – Get Bus Parameters

This packet can be used to retrieve the current bus parameters

All parameters used by the confirmation packet are also used by the request packet CANOPEN_APS_SET_CONFIGURATION_REQ/CNF – Set Configuration with the same meaning and in the same way.

For a precise description of these parameters,, see *Table 45: Bus parameter structure CANOPEN_SLAVE_BUSPARAM_DATA_T* on page 78. and the description given there.

Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_GET_BUSPARAM_REQ_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_GET_BUSPARAM_REQ_Ttag
  CANOPEN_SLAVE_PACKET_GET_BUSPARAM_REQ_T;

/** Structure of task command get bus parameter request */
struct CANOPEN_SLAVE_PACKET_GET_BUSPARAM_REQ_Ttag
{
  TLR_PACKET_HEADER_T tHead;  /** packet header.       */
};
/*****************************************************************************/
```

Packet Description

structure CANOPEN_SLAVE_PACKET_GET_BUSPARAM_REQ_T				Type: Request
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	structure TLR_PACKET_HEADER_T			
	ulDest	UINT32	0x20/ QUE_CANOPEN SLV	Destination Queue-Handle
	ulSrc	UINT32	0 ... 2^{32}-1	Source Queue-Handle
	ulDestId	UINT32	ulCANOPENSL V0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process. Set to 0 for the Initialization Packet
	ulSrcId	UINT32	ulAPSS0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	0	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32	0	See section 6.2 *Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x2934	CANOPEN_SLAVE_GET_BUSPARAM_REQ - Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch

Table 104: CANOPEN_SLAVE_PACKET_GET_BUSPARAM_REQ_T - Get Bus Parameters Request

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Packet Structure Reference

```
/*****************************************************************************/

 struct CANOPEN_SLAVE_STD_BUSPARAM_DATA_Ttag
{
  TLR_UINT32 ulVendorId;       /* Vendor ID              */
  TLR_UINT32 ulProductCode;    /* Product code           */
  TLR_UINT32 ulSerialNumber;   /* Serial number          */
  TLR_UINT32 ulRevisionNumber; /* Revision number        */
  TLR_UINT32 ulDeviceType;     /* Device Type            */

  TLR_UINT8  bObject2000Size;  /* Size of object 2000    */
  TLR_UINT8  bObject2001Size;  /* Size of object 2001    */
  TLR_UINT8  bObject2002Size;  /* Size of object 2002    */
  TLR_UINT8  bObject2003Size;  /* Size of object 2003    */

  TLR_UINT8  bObject2200Size;  /* Size of object 2200    */
  TLR_UINT8  bObject2201Size;  /* Size of object 2201    */
  TLR_UINT8  bObject2202Size;  /* Size of object 2202    */
  TLR_UINT8  bObject2203Size;  /* Size of object 2203    */

  TLR_UINT16 usNumOfRxPdo;     /* Number of receive PDOs  */
  TLR_UINT16 usNumOfTxPdo;     /* Number of transmit PDOs */

  TLR_UINT32 aulReserved[2];   /* Reserved, set to zero   */
};

 struct CANOPEN_SLAVE_EXT_BUSPARAM_DATA_Ttag
{
  TLR_UINT16 usNumOfRxPdo;     /* Number of receive PDOs  */
  TLR_UINT16 usNumOfTxPdo;     /* Number of transmit PDOs */
  TLR_UINT32 aulReserved[9];   /* Reserved, set to zero   */
};

/*****************************************************************************/
/** Structure of task command set bus param data */
 struct CANOPEN_SLAVE_BUSPARAM_DATA_Ttag
{
  TLR_UINT32 ulSlaveNodeId;  /* Node ID       */
  TLR_UINT32 ulBaudrate;     /* Baud-rate     */
  TLR_UINT32 ulCanOpenFlags; /* CANopen flags */

   union {
    CANOPEN_SLAVE_STD_BUSPARAM_DATA_T tStdBusParam; /* Parameter for standard
mode*/
    CANOPEN_SLAVE_EXT_BUSPARAM_DATA_T tExtBusParam; /* Parameter for extended
mode*/
  } uMode;

  TLR_UINT32 ul29BitCode; /* 29Bit Code */
  TLR_UINT32 ul29BitMask; /* 29Bit Mask */
};

/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_BUSPARAM_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_BUSPARAM_DATA_Ttag
  CANOPEN_SLAVE_GET_BUSPARAM_CNF_DATA_T;

/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_GET_BUSPARAM_CNF_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_GET_BUSPARAM_CNF_Ttag
  CANOPEN_SLAVE_PACKET_GET_BUSPARAM_CNF_T;

/** Structure of task command get bus parameter confirmation */
struct CANOPEN_SLAVE_PACKET_GET_BUSPARAM_CNF_Ttag
{
```


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```
  TLR_PACKET_HEADER_T                   tHead;  /** packet header. */
  CANOPEN_SLAVE_GET_BUSPARAM_CNF_DATA_T tData;  /** packet data.   */
};
/*****************************************************************************/
```


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Packet Description

structure CANOPEN_SLAVE_PACKET_GET_BUSPARAM_CNF_T				Type: Confirmation
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle
	ulSrc	UINT32		Source Queue-Handle
	ulDestId	UINT32	ulAPSS0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process. Set to 0 for the Initialization Packet
	ulSrcId	UINT32	ulCANOPENSLV0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	60	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32		See section 6.2 *Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x2935	CANOPEN_SLAVE_GET_BUSPARAM_CNF - Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch
tData	structure CANOPEN_SLAVE_GET_BUSPARAM_CNF_DATA_T			
	tBusParam	CANOPEN_SLAVE_BUSPARAM_DATA_T	Structure	Bus parameter structure, see *Table 45: Bus parameter structure CANOPEN_SLAVE_BUSPARAM_DATA_T*

Table 105: CANOPEN_SLAVE_PACKET_GET_BUSPARAM_CNF_T - Confirmation to Get Bus Parameters Request

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5.2.22 CANOPEN_SLAVE_SET_WATCHDOG_FAIL_REQ/CNF – Set Watchdog Fail

This packet is used by the AP-Task in order to inform the CANopen slave-task that a watchdog failure has been detected. The CANopen slave-task stops the communication with the CANopen network. After a watchdog error has been set, the slave has to be reinitialized before further communication is possible.

Note: Use this packet only when working with linkable object modules. It is not designed for usage in the context of loadable firmware.

Note: This packet is used by the AP-task only and will not be routed from the user application to the CANopen slave-task.

Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_SET_WATCHDOG_FAIL_REQ_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_SET_WATCHDOG_FAIL_REQ_Ttag
  CANOPEN_SLAVE_PACKET_SET_WATCHDOG_FAIL_REQ_T;

struct CANOPEN_SLAVE_PACKET_SET_WATCHDOG_FAIL_REQ_Ttag
{
  TLR_PACKET_HEADER_T tHead; /** packet header.            */
};
/*****************************************************************************/
```

Packet Description

Structure Information CANOPEN_SLAVE_PACKET_SET_WATCHDOG_FAIL_REQ_T				Type: Request
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	Structure TLR_PACKET_HEADER_T			
	ulDest	UINT32	QUE_CANOPENSLV	Destination Queue-Handle of CANopen slave-Task Process Queue
	ulSrc	UINT32	0 ... 2^{32}-1	Source Queue-Handle of AP-Task Process Queue
	ulDestId	UINT32	ulCANOPENSLV0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process
	ulSrcId	UINT32	ulAPSS0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	0	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32	0	See section 6.2 *Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x29AA	CANOPEN_SLAVE_SET_WATCHDOG_FAIL_REQ - Command
	ulExt	UINT32	0	Reserved
	ulRout	UINT32	x	Routing Information

Table 106: CANOPEN_SLAVE_PACKET_SET_WATCHDOG_FAIL_REQ_T – Set Watchdog Fail Request

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Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_SET_WATCHDOG_FAIL_CNF_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_SET_WATCHDOG_FAIL_CNF_Ttag
  CANOPEN_SLAVE_PACKET_SET_WATCHDOG_FAIL_CNF_T;

struct CANOPEN_SLAVE_PACKET_SET_WATCHDOG_FAIL_CNF_Ttag
{
  TLR_PACKET_HEADER_T tHead; /** packet header.           */

};
/*****************************************************************************/
```

Packet Description

Structure Information CANOPEN_SLAVE_PACKET_SET_WATCHDOG_FAIL_CNF_T				**Type: Confirmation**
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	Structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle, untouched
	ulSrc	UINT32		Source Queue-Handle, untouched
	ulDestId	UINT32	ulAPSS0Id	Destination End Point Identifier, untouched
	ulSrcId	UINT32	ulCANOPENSLV0Id	Source End Point Identifier, untouched
	ulLen	UINT32	0	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32		See section 6.2 *Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x29AB	CANOPEN_SLAVE_SET_WATCHDOG_FAIL_CNF– Command
	ulExt	UINT32		Extension, reserved
	ulRout	UINT32		Routing Information, do not change

Table 107: CANOPEN_SLAVE_PACKET_SET_WATCHDOG_FAIL_CNF_T – Set Watchdog Fail Confirmation

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5.2.23 CANOPEN_SLAVE_SETUP_PDO_INDICATION_REQ/CNF – Setup PDO Indication

This request can be used by the application for enabling and disabling PDO indications. While enabled, the CANopen slave sends an indication with each received PDO to the application. The PDO indication is described in section CANOPEN_SLAVE_RECEIVE_PDO_IND/RES – Receive PDO in this manual.

The parameter ulSetupPdoIndication can be used to decide whether you want to disable (1) or enable PDO indications (2 or 3) and whether you want to send multiple PDOs within a single packet

Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_SETUP_PDO_INDICATION_REQ_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_SETUP_PDO_INDICATION_REQ_DATA_Ttag
  CANOPEN_SLAVE_SETUP_PDO_INDICATION_REQ_DATA_T;

#define CANOPEN_SLAVE_SETUP_PDO_INDICATION_DISABLE    0x000000001L
#define CANOPEN_SLAVE_SETUP_PDO_INDICATION_ENABLE     0x000000002L
#define CANOPEN_SLAVE_SETUP_PDO_INDICATION_ENABLE_EXT 0x000000003L

struct CANOPEN_SLAVE_SETUP_PDO_INDICATION_REQ_DATA_Ttag
{
  TLR_UINT32 ulSetupPdoIndication; /* Parameter for PDO indications*/

};

/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_SETUP_PDO_INDICATION_REQ_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_SETUP_PDO_INDICATION_REQ_Ttag
  CANOPEN_SLAVE_PACKET_SETUP_PDO_INDICATION_REQ_T;

struct CANOPEN_SLAVE_PACKET_SETUP_PDO_INDICATION_REQ_Ttag
{
  TLR_PACKET_HEADER_T                          tHead; /** packet header. */
  CANOPEN_SLAVE_SETUP_PDO_INDICATION_REQ_DATA_T tData; /** packet data.   */

};
/*****************************************************************************/
```


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Packet Description

Structure Information CANOPEN_SLAVE_PACKET_SETUP_PDO_INDICATION_REQ_T				Type: Request
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	Structure TLR_PACKET_HEADER_T			
	ulDest	UINT32	0x20/ QUE_CANOPEN SLV	Destination Queue-Handle of CANopen slave-Task Process Queue
	ulSrc	UINT32	0 ... 2^{32}-1	Source Queue-Handle of AP-Task Process Queue
	ulDestId	UINT32	ulCANOPENSL V0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process
	ulSrcId	UINT32	ulAPSS0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	4	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32	0	See section 6.2 *Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x29BA	CANOPEN_SLAVE_SETUP_PDO_INDICATION_REQ- Command
	ulExt	UINT32	0	Reserved
	ulRout	UINT32	x	Routing Information
tData	Structure CANOPEN_SLAVE_SETUP_PDO_INDICATION_REQ_DATA_T			
	ulSetupPdoIn dication	UINT32	0x00000001 0x00000002 0x00000003	*Disable PDO Indications* *Enable PDO Indication* *Enable PDO Indication (for multiple PDO transfer)*

Table 108: CANOPEN_SLAVE_PACKET_SETUP_PDO_INDICATION_REQ_T – Setup PDO Indication Request

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Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_SETUP_PDO_INDICATION_CNF_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_SETUP_PDO_INDICATION_CNF_Ttag
  CANOPEN_SLAVE_PACKET_SETUP_PDO_INDICATION_CNF_T;

struct CANOPEN_SLAVE_PACKET_SETUP_PDO_INDICATION_CNF_Ttag
{
  TLR_PACKET_HEADER_T tHead;                        /** packet header. */

};
/*****************************************************************************/
```

Packet Description

Structure Information CANOPEN_SLAVE_PACKET_SETUP_PDO_INDICATION_CNF_T				**Type: Confirmation**
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	Structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle, untouched
	ulSrc	UINT32		Source Queue-Handle, untouched
	ulDestId	UINT32	ulAPSS0Id	Destination End Point Identifier, untouched
	ulSrcId	UINT32	ulCANOPENSLV 0Id	Source End Point Identifier, untouched
	ulLen	UINT32	0	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32		See section 6.2 *Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x29BB	CANOPEN_SLAVE_SETUP_PDO_INDICATION_CNF– Command
	ulExt	UINT32		Extension, reserved
	ulRout	UINT32		Routing Information, do not change

Table 109: CANOPEN_SLAVE_PACKET_SETUP_PDO_INDICATION_CNF_T – Setup PDO Indication Confirmation

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5.2.24 CANOPEN_SLAVE_RECEIVE_PDO_IND/RES – Receive PDO Indication

The following indication is sent from the CANopen slave to the application each time a PDO is received. The indication includes

- the PDO number,
- the identifier (COB-ID),
- the length and
- the data.

Note: No PDO indications are sent to the application until this functionality is explicitly enabled. Enabling PDO indications is described in this manual in section CANOPEN_SLAVE_SETUP_PDO_INDICATION_REQ/CNF – Setup PDO Indication. Enabling can be done for single or multiple PDO transfer with one packet.

Packet Structure Reference

```
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_RECEIVE_PDO_IND_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_RECEIVE_PDO_IND_DATA_Ttag
  CANOPEN_SLAVE_RECEIVE_PDO_IND_DATA_T;
/** type of <code>CANOPEN_SLAVE_PDO_DATA_Ttag</code> */
typedef struct CANOPEN_SLAVE_PDO_DATA_Ttag
  CANOPEN_SLAVE_PDO_DATA_T;

#define CANOPEN_SLAVE_RECEIVE_PDO_IND_MAX       16
#define CANOPEN_SLAVE_RECEIVE_PDO_IND_MAX_DATA  8

struct CANOPEN_SLAVE_PDO_DATA_Ttag
{
  TLR_UINT32 ulPdoNumber;                                    /* PDO number     */
  TLR_UINT32 ulIdentifier;                                   /* CAN identifier */
  TLR_UINT32 ulLength;                                       /* Data length    */
  TLR_UINT8  abPdoData[CANOPEN_SLAVE_RECEIVE_PDO_IND_MAX_DATA]; /* PDO data
*/
};

struct CANOPEN_SLAVE_RECEIVE_PDO_IND_DATA_Ttag
{
  CANOPEN_SLAVE_PDO_DATA_T atPdoData[CANOPEN_SLAVE_RECEIVE_PDO_IND_MAX];
};
/*****************************************************************************/
/** type of <code>CANOPEN_SLAVE_PACKET_RECEIVE_PDO_IND_Ttag</code> */
typedef struct CANOPEN_SLAVE_PACKET_RECEIVE_PDO_IND_Ttag
  CANOPEN_SLAVE_PACKET_RECEIVE_PDO_IND_T;

struct CANOPEN_SLAVE_PACKET_RECEIVE_PDO_IND_Ttag
{
  TLR_PACKET_HEADER_T                 tHead; /** packet header. */
  CANOPEN_SLAVE_RECEIVE_PDO_IND_DATA_T tData; /** packet data.   */

};
/*****************************************************************************/
```


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Packet Description

Structure Information CANOPEN_SLAVE_PACKET_RECEIVE_PDO_IND_T				Type: Indication
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	Structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle of AP-Task Process Queue
	ulSrc	UINT32		Source Queue-Handle of CANopen slave-Task Process Queue
	ulDestId	UINT32	ulAPSS0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process
	ulSrcId	UINT32	ulCANOPENSLV0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	12 .. 20	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32		See section 6.2 *Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x000029BC	CANOPEN_SLAVE_RECEIVE_PDO_IND- Indication
	ulExt	UINT32	0	Reserved
	ulRout	UINT32	x	Routing Information
tData	Structure CANOPEN_SLAVE_RECEIVE_PDO_IND_DATA_T			
	ulPdoNumber	UINT32	1..255	Number of received PDO
	ulIdentifier	UINT32	0..2047	Identifier (COB-ID) of received PDO
	ulLength	UINT32	0..8	Length of received PDO
	abPdoData[8]	UINT8[8]		Data of received PDO

Table 110: CANOPEN_SLAVE_PACKET_RECEIVE_PDO_IND_T – Receive PDO Indication

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Packet Structure Reference

```
typedef struct CANOPEN_SLAVE_PACKET_RECEIVE_PDO_RES_Ttag
  CANOPEN_SLAVE_PACKET_RECEIVE_PDO_RES_T;

struct CANOPEN_SLAVE_PACKET_RECEIVE_PDO_RES_Ttag
{
  TLR_PACKET_HEADER_T tHead; /** packet header.            */
};
```

Packet Description

Structure Information CANOPEN_SLAVE_PACKET_RECEIVE_PDO_RES_T				**Type: Response**
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	Structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination Queue-Handle of CANopen slave-Task Process Queue
	ulSrc	UINT32		Source Queue-Handle of AP-Task Process Queue
	ulDestId	UINT32	ulCANOPENSLV0Id	Destination End Point Identifier, specifying the final receiver of the packet within the Destination Process. Set to 0 for the Initialization Packet
	ulSrcId	UINT32	ulAPSS0Id	Source End Point Identifier, specifying the origin of the packet inside the Source Process
	ulLen	UINT32	0	Packet Data Length in bytes
	ulId	UINT32	0 ... 2^{32}-1	Packet Identification as unique number generated by the Source Process of the Packet
	ulSta	UINT32		See section 6.2 *Codes of the CANopen Slave-Task*
	ulCmd	UINT32	0x000029BD	CANOPEN_SLAVE_RECEIVE_PDO_RES - Command
	ulExt	UINT32		Extension, reserved
	ulRout	UINT32		Routing Information, do not change

Table 111: CANOPEN_SLAVE_PACKET_RECEIVE_PDO_RES_T – Receive PDO Response

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5.3 Hardware Switches for the Adjustment of Slave Address and Baudrate

For handling address and baud rate switches on a netX device, the firmware must be enabled to evaluate the switch values from the hardware. This can be done by setting a special TAG via the “Tag List Editor” tool. In this case, the values which are configured via database or packet interface will be ignored.

If the hardware switch function is not enabled via TAG, then the firmware uses the values set either via NXD or IniBatch database or via packet interface (SET_CONFIGURATION_REQ or RCX_SET_HW_SWITCH_VALUE_REQ)

(See section 5.3.1 “*RCX_SET_HW_SWITCH_VALUES_REQ/CNF – Set the Values of the Hardware Switch”*).

Enabling and disabling Address and Baudrate Switching

On database files and SET_CONFIGURATION_REQ evaluating the switches can be activated or deactivated. This information is located at the SystemFlags

- CCLINK_APS_SYS_FLAG_ADDRESS_SWITCH = 0x10
- CCLINK_APS_SYS_FLAG_BAUD_SWITCH = 0x20.

Also see section 5.1.2 “CANOPEN_APS_SET_CONFIGURATION_REQ/CNF – Set Configuration”.

Behavior at Start-up

In general, the firmware stack can be configured in different ways. Only one type of configuration can be active at a certain time. These are evaluated at start-up in the following order:

- SYCON.net database
- iniBatch database (via netX Configuration Tool)
- Warmstart Request packet (compatibility)
- Set Configuration Request packet

After a Restart the stack will first search for the SYCON.net database files (config.nxd). If these are found all other configuration methods will not be accepted. If no SYCON.net database exists, but an iniBatch database exists, its configuration will be used and configuration packets will be not accepted.

If no database is found the stack is unconfigured until the receipt of the first configuration packet. In this case the firmware waits for the SET_CONFIGURATION_REQ or WARMSTART_REQ packet. Once one of these packets (i.e. SET_CONFIGURATION_REQ) was received, the other one (i.e WARMSTART_REQ) will be rejected.

The host has the possibility to modify the configuration with the packet RCX_SET_HW_SWITCH_VALUE_REQ

Using the hardware switches for adjusting of slave address and baudrate requires the option *Application_controlled* being active (either when configuring using SET_CONFIGURATION_REQ packet (see CANOPEN_APS_SET_CONFIGURATION_REQ/CNF – Set Configuration on page 77) or in the SYCON.net database file config.nxd).

The stack will start the device with the received configuration as soon as the application ready flag is set by the host application.

On starting the stack the hardware switches are evaluated if hardware switches are enabled via the TAG. The values from the hardware switches will overwrite the values, which was set

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via database or packet previously. This can be avoided if the hardware switches are disabled via the “Tag List Editor” tool. A description of the “Tag List Editor” tool is given in reference [3].

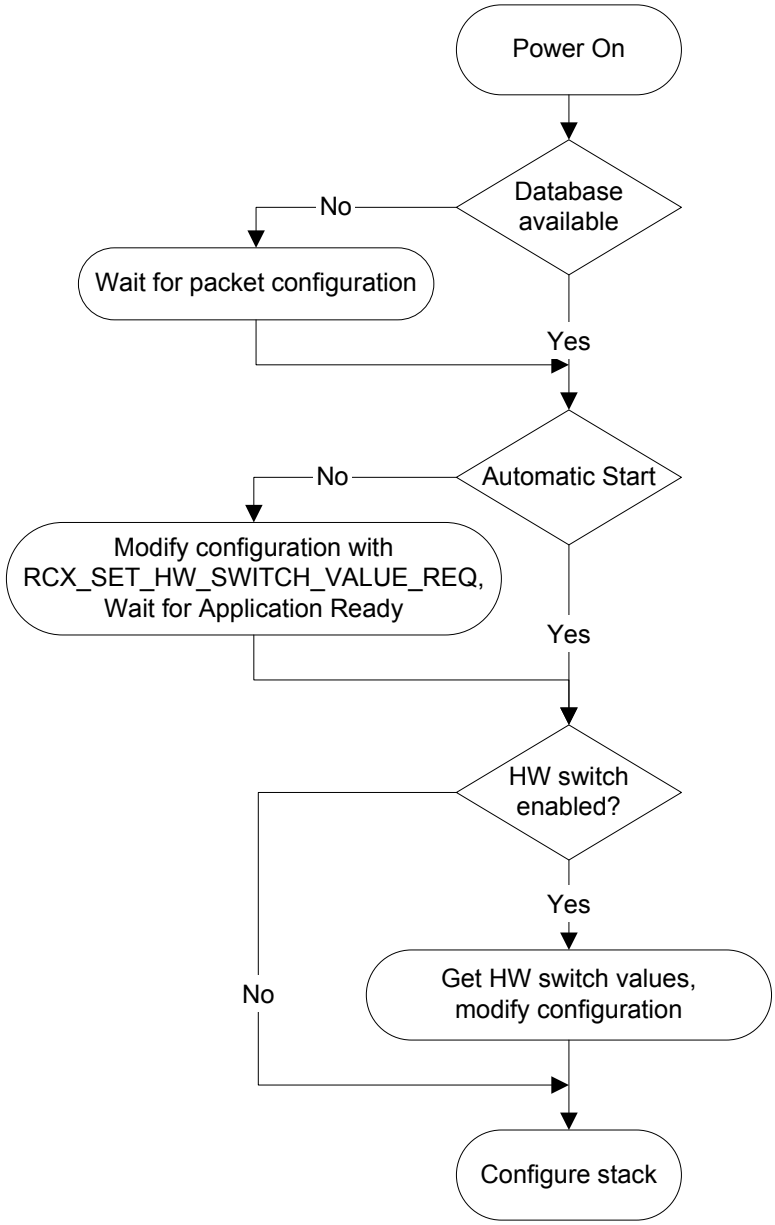

Figure 20: Start-up Process

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5.3.1 RCX_SET_HW_SWITCH_VALUES_REQ/CNF – Set the Values of the Hardware Switch

If the Host application needs to change or set the hardware switch value, the RCX_SET_HW_SWITCH_VALUES_REQ packet shall be used to transmit the values to the stack. These values can be a new station address or a new baud rate setting, for instance. In this case it is necessary that the device has already received a default configuration and is waiting for application ready or BUS_ON signal. As soon application ready is set by the host application the device starts with the last received parameters. This means that the hardware switch values shall be set before the application ready is set.

The data area of the packet contains:

- the number of switches to service (variable ulNumberOfSwitches)
- and as many structures of type TLR_SWITCH_VALUE_T describing a single switch as corresponds to the number of switches (i.e. the content of variable ulNumberOfSwitches):

The structure contains a string uniquely identifying the described switch and the switch value, i.e. the value set on the respective hardware switch

It looks like:

structure tSwitchValue (Type TLR_SWITCH_VALUE_T)			
Variable	**Type**	**Value / Range**	**Description**
abSwitchName	UINT8[16]	char	Switch Name Identifier string. Max. 16 characters
ulValue	UINT32	0 ... 2^{32} -1	Switch value

Table 112: tSwitchValue – Structure of Switch Value set

Initialization behavior:

At the CHANNEL_INIT the stack shall store the value of the hardware switch (i.e. device address) which is set by the previous RCX_SET_HW_SWITCH_VALUES_REQ packet. Only with a SYSTEM_RESET the device address shall be reset and a configuration with a new RCX_SET_HW_SWITCH_VALUES_REQ packet shall be done. The behaviour using the configuration packet SET_CONFIG_REQ is the same.

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Packet Structure Reference

```
typedef struct TLR_SWITCH_VALUE_Ttag
{
  TLR_UINT8[16] abSwitchName;        /* Switch Name Identifier (i.e.“BAUD_RATE”) */
  TLR_UINT32    ulSwitchValue;       /* HW Switch Value to set                   */
} TLR_SWITCH_VALUE_T;

typedef struct RCX_SET_HW_SWITCH_VALUES_REQ_DATA_Ttag
{
  TLR_UINT32 ulNumberOfSwitches;  /*
  TLR_SWITCH_VALUE_T tSwitchValue;          /* structure: “Switch_Name”, Value */
                                            /* used as much as NumberOfSwitches */
} RCX_SET_HW_SWITCH_VALUES_REQ_DATA_T;

typedef struct RCX_SET_HW_SWITCH_VALUES_REQ_Ttag
{
  TLR_PACKET_HEADER_T tHead;           /* packet header */
  RCX_SET_HW_SWITCH_VALUES_REQ_DATA_T tData;
} RCX_SET_HW_SWITCH_VALUES_REQ_T;
```

Packet Description

structure RCX_SET_HW_SWITCH_VALUES_REQ_T				**Type: Request**
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination queue handle of application task process queue
	ulSrc	UINT32		Source Queue-Handle of PNSIF task process queue
	ulDestId	UINT32	0	Destination End Point Identifier
	ulSrcId	UINT32	0 ... 2^{32} -1	Source End Point Identifier, specifying the origin of the packet inside the Source Process.
	ulLen	UINT32	4+20*N	Packet data length in bytes. N depends on the number of used switch values.
	ulId	UINT32	0 ... 2^{32} -1	Packet identification as unique number generated by the source process of the packet
	ulSta	UINT32		Status not used for request.
	ulCmd	UINT32		RCX_SET_HW_SWITCH_VALUES_REQ - Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch
tData	structure RCX_SET_HW_SWITCH_VALUES_REQ_DATA_T			
	ulNumberOfSwitches	UINT32	0-10	The number of used hardware switches.
	tSwitchValue		See below	The tSwitchValue structures, which contain the name and value for each switch.

Table 113: RCX_SET_HW_SWITCH_VALUES_REQ_T – Set Hardware Switch Values Request

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Packet Structure Reference

```
typedef struct RCX_SET_HW_SWITCH_VALUES_CNF_DATA_Ttag
{
} RCX_SET_HW_SWITCH_VALUES_CNF_DATA_T;

typedef RCX_SET_HW_SWITCH_VALUES_CNF_Ttag
{
  TLR_PACKET_HEADER_T                        tHead;    /* packet header */
  RCX_SET_HW_SWITCH_VALUES_CNF_DATA_T        tData;    /* packet data */
} RCX_SET_HW_SWITCH_VALUES_CNF_T;

#define RCX_SET_HW_SWITCH_VALUES_CNF_PACKET_SIZE
                 sizeof(RCX_SET_HW_SWITCH_VALUES_CNF_T)
```

Packet Description

structure RCX_SET_HW_SWITCH_VALUE_CNF_T				**Type: Confirmation**
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination queue handle, do not touch
	ulSrc	UINT32		Source Queue-Handle, do not touch
	ulDestId	UINT32	0	Destination End Point Identifier. Not in use, set to zero for compatibility reasons.
	ulSrcId	UINT32	0 ... 2^{32} -1	Source End Point Identifier, do not touch.
	ulLen	UINT32	0	Packet data length in bytes.
	ulId	UINT32	0 ... 2^{32} -1	Packet identification, untouched
	ulSta	UINT32		Error code. Either TLR_S_OK or TLR_E_FAIL
	ulCmd	UINT32		RCX_SET_HW_SWITCH_VALUES_CNF - Command
	ulExt	UINT32	0	Extension, untouched
	ulRout	UINT32	x	Routing, do not touch

Table 114: RCX_SET_HW_SWITCH_VALUES_CNF – Confirmation to Set Hardware Switch Values Request

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5.3.2 RCX_SET_FW_PARAMETER_REQ/CNF – Set the Value of the Firmware Parameter

This packet informs the stack that a new value of the chosen firmware parameter should be set (i.e. hardware switch value, address or “Name of Station” etc.). The data area of the packet is defined using the `TLV (Tag(ParameterID) – Length – Value)` format. One or more parameters can be set with a one packet. The amount of parameter is limited by the max. packet length.

The parameter list is simply a sequence of parameter entries, each of which is aligned on a DWORD boundary. There is no need for the parameters to obey to a specific sequence. The Parameter Data Length entry contains the real length of the parameter. The relative offset (in bytes) of the next entry's Parameter ID field is calculated based on the length of the previous parameter rounded up to the next DWORD address.

The last (or the only existing) parameter can optionally be padded.

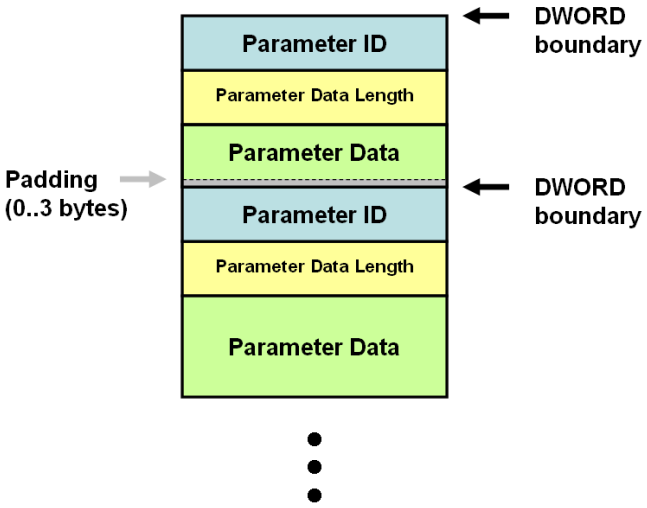

Figure 21: Parameter List Structure

Known Parameter IDs

The following tables summarize the known Parameter ID codes and the corresponding run-time configuration information. For convenience reasons, the Parameter ID codes are grouped as given below:

- 0x00000000 – 0x000007FF reserved
- 0x00000800 – 0x00000FFF reserved
- 0x00001000 – 0x00FFFFFF reserved
- 0x10000000 – 0x1FFFFFFF reserved
- 0x20000000 – 0x2FFFFFFF reserved
- 0x30000000 – 0x3FFFFFFF Protocol Parameter IDs
- 0x40000000 – 0x4FFFFFFF reserved

All other Tag Type codes are reserved for future use.

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Protocol Parameter IDs provide the means of configuring the settings of a protocol stack as a whole, e.g. the activation of features, IDs and names used for identification, or network address assignment settings.

The encoding of the protocol tag IDs is structured as follows: 0xPCCCCNNN, where

- P = prefix (bits 31...28, always 0x3)
- CCCC = protocol class (bits 27...12, defined in the netX DPM Interface Manual [1])
- NNN = unique number (bits 11...0)

The following table shows the defined protocol specific Parameter IDs

Protocol Parameter IDs			
Parameter ID	**Code**	**Parameter Data Length**	**Description**
PID_STATION_ADDRESS	0x30000001	4	Station address of device (UINT32)
PID_BAUDRATE	0x30000002	4	Baud rate of device (UINT32)
PID_PN_NAME_OF_STATION	0x30015001	240	PROFINET Name of Station String Name of Station (STRING[240])
PID_ECS_DEVICE_IDENTIFICATION	0x30009001	4	Value for Explicit Device Identification (UINT16)
PID_ECS_SCND_STATION_ADDRESS	0x30009002	4	Second Station Address (UINT16)

Table 115: Protocol Parameter IDs

Behavior of firmware while evaluating RCX_SET_FW_PARAMETER_REQ

The following table shows how the firmware reacts in common error situations:

Situation	Errorcode
The packet length is invalid.	TLR_E_INVALID_PACKET_LEN
The field ulParameterID contains an unknown value.	TLR_E_INVALID_PARAMETER
The field ulParameterLength contains an invalid value.	TLR_E_INCONSISTENT_DATA_SET
The content of abParameter is invalid.	TLR_E_PARAMETER_ERROR
The firmware is not configured at all (no database found).	TLR_E_NOT_CONFIGURED

Table 116: Common error scenarios and error codes to use

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Packet Structure Reference

```
typedef struct RCX_SET_FW_PARAMETER_REQ_DATA_Ttag
{
  TLR_UINT32 ulParameterID;
  TLR_UINT32 ulParameterLen;
  TLR_UINT8  abParameter[ulParameterLen];  /* padded to DWORD boundary*/
...  /* next parameter */
} RCX_SET_FW_PARAMETER_REQ_DATA_T;

typedef struct RCX_SET_FW_PARAMETER_REQ_Ttag
{
  TLR_PACKET_HEADER_T tHead;            /* packet header */
  RCX_SET_FW_PARAMETER_REQ_DATA_T tData;
} RCX_SET_FW_PARAMETER_REQ_T;
```

Packet Description

structure RCX_SET_FW_PARAMETER_REQ_T				**Type: Request**
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination queue handle of application task process queue
	ulSrc	UINT32		Source Queue-Handle of PNSIF task process queue
	ulDestId	UINT32	0	Destination End Point Identifier
	ulSrcId	UINT32	0 ... 2^{32} -1	Source End Point Identifier, specifying the origin of the packet inside the Source Process.
	ulLen	UINT32	8+ ulParameterLen	Packet data length in bytes. N depends on the number of used switch values.
	ulId	UINT32	0 ... 2^{32} -1	Packet identification as unique number generated by the source process of the packet
	ulSta	UINT32		Status not used for request.
	ulCmd	UINT32	0x00002F86	RCX_SET_FW_PARAMETER_REQ - Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch
tData	structure RCX_SET_FW_PARAMETER_REQ_DATA_T			
	ulParameterID	UINT32	0-0xFFFFFFFF	The number of used hardware switches.
	ulParameterLen	UINT32	See below	Length of the parameter in bytes.
	abParameter[]	UINT8[]		Parameter Value as a byte array.
				Next parameter may follow.

Table 117: RCX_SET_FW_PARAMETER_REQ_T – Set Value of the Firmware Parameter Request

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Packet Structure Reference

```
typedef struct RCX_SET_FW_PARAMETER_CNF_DATA_Ttag
{
} RCX_SET_FW_PARAMETER_CNF_DATA_T;

typedef RCX_SET_FW_PARAMETER_CNF_Ttag
{
  TLR_PACKET_HEADER_T                       tHead;    /* packet header */
  RCX_SET_FW_PARAMETER_CNF_DATA_T           tData;    /* packet data */
} RCX_SET_FW_PARAMETER_CNF_T;

#define RCX_SET_FW_PARAMETER_CNF_PACKET_SIZE
                 sizeof(RCX_SET_FW_PARAMETER_CNF_T)
```

Packet Description

structure RCX_SET_FW_PARAMETER_CNF_T				**Type: Confirmation**
Area	**Variable**	**Type**	**Value / Range**	**Description**
tHead	structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination queue handle of application task process queue
	ulSrc	UINT32		Source Queue-Handle of PNSIF task process queue
	ulDestId	UINT32	0	Destination End Point Identifier
	ulSrcId	UINT32	0 ... 2^{32} -1	Source End Point Identifier, specifying the origin of the packet inside the Source Process.
	ulLen	UINT32	0	Packet data length in bytes. N depends on the number of used switch values.
	ulId	UINT32	0 ... 2^{32} -1	Packet identification as unique number generated by the source process of the packet
	ulSta	UINT32		Status
	ulCmd	UINT32	0x00002F87	RCX_SET_FW_PARAMETER_CNF - Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch

Table 118: RCX_SET_FW_PARAMETER_CNF_T – Confirmation to the Set Value of the Firmware Parameter Request

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5.3.3 RCX_GET_FW_PARAMETER_REQ/CNF – Get the Value of the Firmware Parameter

This packet delivers the current value of the chosen firmware parameter (i.e. hardware switch value, address or “Name of Station” etc.). The data area of the packet is field bus specific and is defined using `TLV (Tag(ParameterID) – Length – Value)` format. One parameter can be requested with each packet.

If the firmware uses a different parameter than the one set by RCX_SET_FW_PARAMETER_REQ (e.g. the hardware switch value changed during runtime which can not be applied by the firmware in runtime) the RCX_GET_FW_PARAMETER_CNF returns the parameter currently used by the firmware and not the one that was set.

Packet Structure Reference

```
typedef struct RCX_GET_FW_PARAMETER_REQ_DATA_Ttag
{
  TLR_UINT32 ulParameterID;
} RCX_GET_FW_PARAMETER_REQ_DATA_T;

typedef struct RCX_GET_FW_PARAMETER_REQ_Ttag
{
  TLR_PACKET_HEADER_T tHead;            /* packet header */
  RCX_GET_FW_PARAMETER_REQ_DATA_T tData;
} RCX_GET_FW_PARAMETER_REQ_T;
```

Packet Description

structure RCX_GET_FW_PARAMETER_REQ_T				
Type: Request				
Area	**Variable**	**Type**	**Value / Range**	**Description**
Head	structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination queue handle of application task process queue
	ulSrc	UINT32		Source Queue-Handle of PNSIF task process queue
	ulDestId	UINT32	0	Destination End Point Identifier
	ulSrcId	UINT32	0 ... 2^{32} -1	Source End Point Identifier, specifying the origin of the packet inside the Source Process.
	ulLen	UINT32	4	Packet data length in bytes.
	ulId	UINT32	0 ... 2^{32} -1	Packet identification as unique number generated by the source process of the packet
	ulSta	UINT32		Status not used for request.
	ulCmd	UINT32	0x2F88	RCX_GET_FW_PARAMETER_REQ – Command
	ulExt	UINT32	0	Extension not in use, set to zero for compatibility reasons
	ulRout	UINT32	x	Routing, do not touch
Data	structure RCX_SET_FW_PARAMETER_REQ_DATA_T			
	ulParameterID	UINT32	0-0xFFFFFFFF	The number of used hardware switches.

Table 119: RCX_GET_FW_PARAMETER_REQ_T – Get Firmware Parameter Request

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Packet Structure Reference

```
typedef struct RCX_GET_FW_PARAMETER_CNF_DATA_Ttag
{
  TLR_UINT32 ulParameterID;
  TLR_UINT32 ulParameterLen;
  TLR_UINT8  abParameter[ulParameterLen];
} RCX_GET_FW_PARAMETER_CNF_DATA_T;

typedef RCX_GET_FW_PARAMETER_CNF_Ttag
{
  TLR_PACKET_HEADER_T                       tHead;    /* packet header */
  RCX_GET_FW_PARAMETER_CNF_DATA_T           tData;    /* packet data */
} RCX_GET_FW_PARAMETER_CNF_T;
```

Packet Description

structure RCX_GET_FW_PARAMETER_CNF_T				
Type: Confirmation				
Area	**Variable**	**Type**	**Value / Range**	**Description**
Head	Structure TLR_PACKET_HEADER_T			
	ulDest	UINT32		Destination queue handle, do not touch
	ulSrc	UINT32		Source Queue-Handle, do not touch
	ulDestId	UINT32	0	Destination End Point Identifier. Not in use, set to zero for compatibility reasons.
	ulSrcId	UINT32	0 ... 2^{32} -1	Source End Point Identifier, do not touch.
	ulLen	UINT32	8 + n	Packet data length in bytes.
	ulId	UINT32	0 ... 2^{32} -1	Packet identification, untouched
	ulSta	UINT32		Error code. Either TLR_S_OK or TLR_E_FAIL
	ulCmd	UINT32	0x2F89	RCX_GET_FW_PARAMETER_CNF - Command
	ulExt	UINT32	0	Extension, untouched
	ulRout	UINT32	x	Routing, do not touch
Data	structure RCX_GET_FW_PARAMETER_REQ_DATA_T			
	ulParameterID	UINT32	0-0xFFFFFFFF	The number of used hardware switches.
	ulParameterLen	UINT32	See below	Length of the parameter in bytes.
	abParameter[]	UINT8[]		Parameter Value as a byte array.

Table 120: RCX_GET_FW_PARAMETER_CNF – Get Firmware Parameter Response

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5.4 CAN-DL Task

If working with Loadable Firmware, you can also use the functionality of the CAN-DL Task for programming CAN on the level of Data Link Layer (Layer 2 in OSI Layer Model).

The packet interface of CAN DL is described within a separate manual, the CAN Data Link Packet Interface Protocol API Manual. See reference # 5.

The following packets of CAN DL can be used without restrictions:

- CAN_DL_CMD_DATA_REQ
- CAN_DL_CMD_DATA_HI_REQ
- CAN_DL_CMD_DIAG_REQ
- CAN_DL_CMD_TX_ABORT_REQ
- CAN_DL_CMD_AP_REGISTER_REQ
- CAN_DL_CMD_EVENT_ACK_REQ

The following packets of CAN DL will be denied as long as the ‘Configuration Lock’ flag is set:

- CAN_DL_CMD_ENABLE_RXID_REQ
- CAN_DL_CMD_SET_EVENTS_TO_INDICATE_REQ

Whether or not indications are sent to your application, depends on which CAN-DL events have been notified!

Contrary to the CANopen Slave Task, the CAN-DL Task also supports 29 bit CAN identifiers. If it is intended to use these 29 bit CAN identifiers, the application has to registered at the CAN-DL Task using CAN_DL_CMD_AP_REGISTER_REQ with parameter ulInitMode set to 0.

5.5 ODV3 Task

If working with Loadable Firmware, you can also use the SDO functionality of the ODV3 Task for accessing the object dictionary.

The packet interface of the Object Dictionary V3 is described within a separate manual, the Object Dictionary V3 Protocol API Manual. See reference # 4.

The following packets of Object Dictionary V3 can be used without any restrictions:

- ODV3_READ_OBJECT_REQ
- ODV3_WRITE_OBJECT_REQ
- ODV3_GET_OBJECT_LIST_REQ
- ODV3_GET_OBJECT_INFO_REQ
- ODV3_GET_SUBOBJECT_INFO_REQ
- ODV3_GET_OBJECT_ACCESS_INFO_REQ
- ODV3_GET_OBJECT_SIZE_REQ
- ODV3_READ_OBJECT_NO_IND_REQ
- ODV3_GET_OBJECT_COUNT_REQ
- ODV3_WRITE_ALL_BY_INDEX_REQ
- ODV3_READ_ALL_BY_INDEX_REQ
- ODV3_WRITE_MULTIPLE_PARAMETER_BY_INDEX_REQ
- ODV3_READ_MULTIPLE_PARAMETER_BY_INDEX_REQ
- ODV3_GET_TIMEOUT_REQ

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The following packets of Object Dictionary V3 will be denied as long as the ‘Configuration Lock’ flag is set:

- ODV3_CREATE_OBJECT_REQ
- ODV3_CREATE_SUBOBJECT_REQ
- ODV3_DELETE_OBJECT_REQ
- ODV3_DELETE_SUBOBJECT_REQ
- ODV3_REGISTER_OBJECT_NOTIFY_REQ
- ODV3_UNREGISTER_OBJECT_NOTIFY_REQ
- ODV3_REGISTER_SUBOBJECT_NOTIFY_REQ
- ODV3_UNREGISTER_SUBOBJECT_NOTIFY_REQ
- ODV3_REGISTER_UNDEFINED_NOTIFY_REQ
- ODV3_UNREGISTER_UNDEFINED_NOTIFY_REQ
- ODV3_REGISTER_OBJINFO_NOTIFY_REQ
- ODV3_UNREGISTER_OBJINFO_NOTIFY_REQ
- ODV3_CREATE_DATATYPE_REQ
- ODV3_DELETE_DATATYPE_REQ
- ODV3_SET_TIMEOUT_REQ
- ODV3_SET_OBJECT_NAME_REQ
- ODV3_SET_SUBOBJECT_NAME_REQ
- ODV3_LOCK_OBJECT_DELETION_REQ
- ODV3_UNLOCK_OBJECT_DELETION_REQ

Whether or not indications are sent to your application, depends on which ODV3 events have been notified!

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6 Status/Error Codes Overview

6.1.1 Codes of the CANopen-APS-Task

6.1.2 Error Messages

Definition / (Value)	Definition / Description
0x00000000	TLR_S_OK Status ok
0xC0000001	TLR_E_FAIL Common error, detailed error information optionally present in the data area of packet
0xC04A0002	TLR_E_CANOPEN_APS_DATABASE_FOUND Configuration database found.
0xC04A0003	TLR_E_CANOPEN_APS_NODE_ID_PARAMETER Invalid parameter for node id.
0xC04A0004	TLR_E_CANOPEN_APS_BAUDRATE_PARAMETER Invalid parameter for baudrate.
0xC04A0005	TLR_E_CANOPEN_APS_STATE Request not possible in current state.
0x404A0007	TLR_I_CANOPEN_APS_OPEN_DBM_FILE Failed to open configuration database.
0xC04A0008	TLR_E_CANOPEN_APS_DATASET Failed to open configuration dataset.
0xC04A0009	TLR_E_CANOPEN_APS_TABLE_GLOBAL Failed to open GLOBAL configuration dataset.
0xC04A000A	TLR_E_CANOPEN_APS_TABLE_BUS_CAN Failed to open BUS_CAN configuration dataset.
0xC04A000B	TLR_E_CANOPEN_APS_SIZE_TABLE_BUS_CAN Invalid size of BUS_CAN configuration dataset.
0x404A000C	TLR_I_CANOPEN_APS_CONFIG_LOCK Configuration is locked.
0xC04A000D	TLR_E_CANOPEN_APS_PACKET_LENGTH Invalid packet length.
0xC04A000E	TLR_E_CANOPEN_APS_WATCHDOG_PARAMETER Invalid parameter for watchdog supervision.
0xC04A000FL	TLR_E_CANOPEN_APS_WATCHDOG_ACTIVATE Failed to activate watchdog supervision.
0xC04A0010	TLR_E_CANOPEN_APS_PARAM_QUEUE_ELEMENT Invalid parameter for number of queue elements.
0xC04A0011	TLR_E_CANOPEN_APS_PARAM_POOL_ELEMENT Invalid parameter for number of pool elements.
0xC04A0012	TLR_E_CANOPEN_APS_PARAM_CYCLETIME Invalid parameter for cycle time.

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Definition / (Value)	Definition / Description
0xC04A0013	TLR_E_CANOPEN_APS_PARAM_CHN_INSTANCE Invalid parameter for channel instance.
0xC04A0014	TLR_E_CANOPEN_APS_NUM_OF_RX_PDO_PARAMETER Invalid parameter for number of receive PDO.
0xC04A0015	TLR_E_CANOPEN_APS_NUM_OF_TX_PDO_PARAMETER Invalid parameter for number of send PDO.
0xC04A0016	TLR_E_CANOPEN_APS_SIZE_TABLE_VERSION Invalid size of table 'Version'.
0xC04A0017	TLR_E_CANOPEN_APS_INVALID_DBM_VERSION Invalid version of table 'Version'.
0xC04A0018	TLR_E_CANOPEN_APS_SIZE_TABLE_BUS_CAN_STD Invalid size of table 'BUS_COS_STD'.
0xC04A0019	TLR_E_CANOPEN_APS_SIZE_TABLE_BUS_CAN_EXT Invalid size of table 'BUS_COS_EXT'.
0xC04A001A	TLR_E_CANOPEN_APS_AUTOSTART_WITH_EXTENDED_MODE Auto start not allowed in extended mode.
0xC04A001B	TLR_E_CANOPEN_APS_ADDRESS_SWITCH_CONFIGURATION_NOT_POSSIBLE Address switch configuration is not possible.
0xC04A001C	TLR_E_CANOPEN_APS_BAUD_SWITCH_CONFIGURATION_NOT_POSSIBLE Baud switch configuration is not possible.
0xC04A001D	TLR_E_CANOPEN_APS_PARAM_LED_MODE Invalid parameter for LED mode.

Table 121: Error Messages of the AP-Task

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6.2 Codes of the CANopen Slave-Task

6.2.1 Error Messages

The following table defined the error messages of the CANopen slave-task:

Definition / (Value)	Description
0x00000000	TLR_S_OK Status ok
0xC0000001	TLR_E_FAIL Common error, detailed error information optionally present in the data area of packet
0xC0430003	TLR_E_CANOPEN_SLAVE_DATA_COUNT Invalid data count.
0xC0430004	TLR_E_CANOPEN_SLAVE_DATA_OFFSET Invalid data offset.
0xC0430005	TLR_E_CANOPEN_SLAVE_DATA_COUNT_WITH_OFFSET Invalid data count in combination with offset.
0xC0430006	TLR_E_CANOPEN_SLAVE_MODE Invalid mode in command.
0xC0430007	TLR_E_CANOPEN_SLAVE_STATE Command is not allowed in current state.
0xC0430009	TLR_E_CANOPEN_SLAVE_BUS_RUNNING Command is not allowed because CANopen is running.
0xC043000A	TLR_E_CANOPEN_SLAVE_BUS_PARAM_ALREADY_SET Bus parameters are already configured.
0xC043000B	TLR_E_CANOPEN_SLAVE_LOCAL_NODE_ID Invalid Node ID for CANopen slave.
0xC043000C	TLR_E_CANOPEN_SLAVE_BAUDRATE Invalid Baudrate.
0xC043000D	TLR_E_CANOPEN_SLAVE_29BIT_SELECTOR Invalid parameter for 29 bit selector.
0x4043000F	TLR_I_CANOPEN_SLAVE_ALREADY_IN_STATE Slave is already in requested state.
0xC0430010	TLR_E_CANOPEN_SLAVE_SEND_EMCY Send emergency-telegram failed.
0xC0430011	TLR_E_CANOPEN_SLAVE_INIT_LIB Failed to initialize CANopen library.
0xC0430012	TLR_E_CANOPEN_SLAVE_ERROR_PASSIVE CANopen is in error-passive state.
0xC0430013	TLR_E_CANOPEN_SLAVE_BUS_OFF CANopen is in bus-off state.
0xC0430014	TLR_E_CANOPEN_SLAVE_PUT_OBJECT_DATA Failed to write object data.

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Definition / (Value)	Description
0xC0430015	TLR_E_CANOPEN_SLAVE_SET_OBJECT_DATA_VALID Failed to set object data valid.
0xC0430016	TLR_E_CANOPEN_SLAVE_GET_OBJECT_DATA Failed to get object data.
0xC0430017	TLR_E_CANOPEN_SLAVE_WRITE_PDO_REQ Failed to transmit PDO.
0xC0430018	TLR_E_CANOPEN_SLAVE_GUARD_ERROR Guard error detected.
0xC0430019	TLR_E_CANOPEN_SLAVE_INIT_BUFFER Initialization of buffer failed.
0xC043001A	TLR_E_CANOPEN_SLAVE_DL_REQ_FAILED CAN-DL request failed.
0xC043001B	TLR_E_CANOPEN_SLAVE_INVALID_INDEX Invalid object index.
0xC043001C	TLR_E_CANOPEN_SLAVE_INVALID_SUB_INDEX Invalid sub-index.
0xC043001D	TLR_E_CANOPEN_SLAVE_INVALID_MAP_LENGTH Invalid mapping length.
0xC043001E	TLR_E_CANOPEN_SLAVE_INVALID_PDO_MODE Invalid transmission mode for PDO.
0xC043001F	TLR_E_CANOPEN_SLAVE_INVALID_PDO_LENGTH Invalid length for PDO.
0xC0430020	TLR_E_CANOPEN_SLAVE_NO_WRITE_PERM No write permission for object.
0xC0430021	TLR_E_CANOPEN_SLAVE_NO_READ_PERM No read permission for object.
0xC0430022	TLR_E_CANOPEN_SLAVE_VALUE_TOO_LOW Value for object too low.
0xC0430023	TLR_E_CANOPEN_SLAVE_VALUE_TOO_HIGH Value for object too high.
0xC0430024	TLR_E_CANOPEN_SLAVE_INVALID_PARAMETER Invalid parameter for object.
0xC0430025	TLR_E_CANOPEN_SLAVE_INVALID_PDO_STATE Invalid PDO state.
0x40430026	TLR_I_CANOPEN_SLAVE_INITIALIZE Slave is initializing.
0xC0430027L	TLR_E_CANOPEN_SLAVE_OBJECT_SIZE Invalid size for object.
0xC0430028	TLR_E_CANOPEN_SLAVE_ID_IN_USE Identifier already in use.
0xC0430029	TLR_E_CANOPEN_SLAVE_INHIBIT Service is inhibited.

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Definition / (Value)	Description
0xC043002A	TLR_E_CANOPEN_SLAVE_TX_OVERRUN Transmit overrun.
0xC043002B	TLR_E_CANOPEN_SLAVE_RX_OVERRUN Receive overrun.
0xC043002C	TLR_E_CANOPEN_SLAVE_ERROR_WARNING CANopen is in error-warning state.
0xC043002D	TLR_E_CANOPEN_SLAVE_RECV_PDO_REQ Request receive PDO failed.
0xC043002E	TLR_E_CANOPEN_SLAVE_NUM_OF_RX_PDO_PARAMETER Invalid parameter for number of receive PDO.
0xC043002F	TLR_E_CANOPEN_SLAVE_NUM_OF_TX_PDO_PARAMETER Invalid parameter for number of send PDO.
0xC0430030	TLR_E_CANOPEN_SLAVE_HB_CONSUMER_PARAMETER Invalid parameter for number of heartbeat consumer.
0xC0430031	TLR_E_CANOPEN_SLAVE_SEND_TIME_STAMP Failed to send timestamp message.

Table 122: Error Messages of the CANopen Slave-Task

6.3 Codes of CAN-DL Task

See separate CAN-DL Task documentation (reference [5]), section 5 *"Status/Error Codes Overview".*

6.4 Codes of ODV3

See separate Object Dictionary V3 documentation (reference [4]), section 6.1 *"Status/Error Codes Object Dictionary".*

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7 Appendix

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